The Department of Defense

DoD DEPARTMENTS:

Department of the Navy

Defense Nuclear Agency

Department of the Air Force

ARPA
Advanced Research Projects Agency

BMDO
Ballistic Missile Defense Organization

PROGRAM SOLICITATION 96.1
CLOSING DATE: 05 JANUARY 1996

FY 1996 SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

PROGRAM SOLICITATION

Number 96.1

Small Business Innovation Research Program

IMPORTANT

The DoD updates its SBIR mailing list annually. To remain on the mailing list or to be added to the list, send in the Mailing List form (Reference E), found at the back of this solicitation, to DTIC. Failure to send the form annually will result in no future mailings of the DoD SBIR Program Solicitation to your address.

For general questions about the Defense Department's SBIR program, please call the SBIR hotline at (800) 382-4634.

U.S. Department of Defense
SBIR Program Office
Washington, DC 20301

Closing Date: JANUARY 5, 1996

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time.

THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, D.C. 20301-3010

ACQUISITION AND
TECHNOLOGY

AUG 1 4 1995

IMPORTANT NEW FEATURES OF THE DEFENSE DEPARTMENT'S SBIR PROGRAM

I am pleased to present the 96.1 SBIR solicitation, which reflects a number of important changes in the Defense Department's SBIR program. These changes were developed by representatives from across the Department, and are designed to significantly increase the program's success in converting SBIR research into affordable, high-performance products which serve the needs of our armed forces. The main changes that will take effect in this solicitation cycle are as follows:

1. Implementation of an SBIR "Fast Track" for projects which obtain outside financing (see Section 4.5 of this solicitation).

On a two-year pilot basis, the Department's SBIR program will feature a fast-track SBIR process for companies which, during their Phase I projects, identify independent third-party investors that will match both Phase II SBIR funding and interim SBIR funding (between Phases I and II), in cash, at the matching rates described in Section 4.5. Companies which obtain such third-party investments and thereby qualify for the SBIR fast track will receive (subject to the qualifications described in Section 4.5): (1) interim SBIR funding between Phases I and II, (2) the Department's highest priority for Phase II funding, and (3) an expedited Phase II selection decision and award.

To enable potential third-party investors to identify Phase I projects in which to invest, the Department will electronically post the abstracts of all selected Phase I awards at the electronic addresses listed in Section 1.6(b) of this solicitation, shortly after the awards are made.

2. Reduction of delays in the SBIR process.

All component SBIR programs within the Department will reduce the time interval between proposal receipt and award to an average of four months in Phase I and an average of six months in Phase II.

3. Opportunity for small companies to ask technical questions about solicitation topics.

Approximately six weeks before each SBIR solicitation opens, the solicitation topics will be pre-released electronically, at the locations listed in Section 1.6(b) of this solicitation, along with the names of topic authors or other technical experts and their phone numbers. This pre-release will give small companies an opportunity to ask technical questions about specific solicitation topics by telephone before the solicitation opens.

Once a solicitation opens, telephone questions will no longer be accepted, and companies may ask questions through the SBIR Interactive Topic Information System (SITIS -- described in Section 7.2), in which the questioner and respondent remain anonymous and all questions and answers are posted electronically for general viewing. The SITIS service opens at the same time as the pre-release and closes to new questions approximately 30 days before the solicitation closes.

Note that the pre-release and SITIS services should only be used to ask technical questions about specific solicitation topics, and that general questions about the SBIR program should be directed to the SBIR hotline (800-382-4634).

4. Other changes.

- To assist companies in preparing Phase I and Phase II proposals, we have electronically posted an example of a successful SBIR proposal at the electronic addresses listed in Section 1.6(b).

- To assist companies in negotiating SBIR contracts, we will post model Phase I and Phase II contracts at the electronic addresses listed in Section 1.6(b), starting in early 1996.

- The Company Commercialization Report requirement has been modified to more accurately measure companies' success in commercializing previous SBIR projects (see Section 3.4(n)).

- Starting with this solicitation, companies will be asked to briefly explain their commercialization strategies in their Phase I and Phase II proposals (see Section 3.4(h)).

- The Department currently maintains an SBIR hotline (800-382-4634) to answer general questions about the parameters of the SBIR program. Starting in early 1996, we will begin increasing the capability of our hotline to address advanced questions in such areas as: proposal preparation strategy, contract negotiation, government accounting requirements, patenting, and financing strategies.

I believe that these changes represent a major step forward in harnessing the innovative talents of small technology companies for the benefit of both the Department of Defense and the U.S. economy. I look forward to your participation in the program.

Paul G. Kaminski

Paul G. Kaminski

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DoD PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Navy, Air Force, Advanced Research Projects Agency (ARPA), Ballistic Missile Defense Organization (BMDO), and Defense Nuclear Agency (DNA) hereafter referred to as DoD Components, invite small business firms to submit proposals under this program solicitation entitled Small Business Innovation Research (SBIR). Firms with strong research and development capabilities in science or engineering in any of the topic areas described in Section 8.0 are encouraged to participate. Subject to availability of funds, DoD Components will support high quality research or research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector.

Objectives of the DoD SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research or research and development results.

The Federal SBIR Program is mandated by Public Laws PL 97-219, PL 99-443, and PL 102-564. The basic design of the DoD SBIR Program is in accordance with the Small Business Administration (SBA) SBIR Policy Directive, January 1993. The DoD Program presented in this solicitation strives to encourage scientific and technical innovation in areas specifically identified by DoD Components. The guidelines presented in this solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

1.2 Three Phase Program

This program solicitation is issued pursuant to the Small Business Innovation Development Act of 1982, PL 97-219, PL 99-443, and PL 102-564. Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR Program and will typically be one half-person year effort over a period not to exceed six months. Proposals should concentrate on that research or research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other applications. If it appears to have such potential, proposers are encouraged, on an optional basis, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the government funded research and development phases.

Subsequent Phase II awards will be made to firms on the basis of results from the Phase I effort and the scientific and technical merit of the Phase II proposal. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research or research and development effort and is expected to produce a well-defined deliverable product or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, the small business is expected to use non-federal capital to pursue private sector applications of the research or development. Also, under Phase III, federal agencies may award non-SBIR funded follow-on contracts for products or processes which meet the mission needs of those agencies. This solicitation is designed, in part, to encourage the conversion of federally sponsored research and development innovation into private sector applications. The federal research and development can serve as both a technical and pre-venture capital base for ideas which may have commercial potential.

This solicitation is for Phase I proposals only. Only proposals submitted in response to this solicitation will considered for Phase I award. Offerors who were not awarded a contract in response to a prior SBIR solicitation are free to update or modify and re-submit the same or modified proposal if it is responsive to any of the topics listed in Section 8.0.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts will be considered (Section 4.3 and 5.2).

DoD is not obligated to make any awards under either Phase I, II, or III. DoD is not responsible for any monies expended by the proposer before award of any contract.

1.3 Follow-On Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is conversion of DoD-supported research or research and development into commercial products. Proposers are encouraged to obtain a contingent commitment for private follow-on funding prior to Phase II where it is felt that the research or research and development has commercial potential in the private sector.

Proposers who feel that their research or research and development have the potential to meet private sector market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue private sector development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent upon the DoD supported research or development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase III. *Note that when several Phase II proposals receive evaluations being of approximately equal merit, proposals that demonstrate such a commitment for follow-on funding will receive extra consideration during the evaluation process.*

The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies as stated in Section 5.7.

1.4 Eligibility and Limitation

Each proposer must qualify as a small business for research or research and development purposes as defined in Section 2.0 and certify to this on the Cover Sheet (Appendix A) of the proposal. In addition, a minimum of two-thirds of each Phase I SBIR project must be carried out by the proposing firm. For Phase II, a minimum of one-half of the effort must be performed by the proposing firm. For both Phase I and II, the primary employment of the principal investigator must be with the small business firm at the time of the award and during the conduct of the proposed effort. Primary employment means that more than one-half of the principal investigator's time is spent with the small business. Deviations from these requirements must be approved in writing by the contracting officer (during contract negotiations).

For both Phase I and Phase II, the research or research and development work must be performed by the small business concern in the United States. "United States" means the fifty states, the Territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia.

Joint ventures and limited partnerships are permitted, provided that the entity created qualifies as a small business in accordance with the Small Business Act, 15 USC 631, and the definition included in Section 2.2.

1.5 Conflicts of Interest

Awards made to firms owned by or employing current or previous Federal Government employees could create conflicts of interest for those employees in violation of 18 USC and 10 USC 2397. Such proposers should contact the cognizant Ethics Counsellor of the DoD Component for further guidance.

1.6 Contact with DoD

a. General Information. General information questions pertaining to proposal instructions contained in this solicitation should be directed to:

SBIR Coordinator
U.S. Department of Defense
OSD/SADBU - The Pentagon, Room 2A338
Washington, DC 20301-3061
(800) 382-4634

Other non-technical questions pertaining to a specific DoD Component should be directed in accordance with instructions given at the beginning of that DoD Component's topics in Section 8.0 of this solicitation. Oral communications with DoD Components regarding the technical content of this solicitation during the Phase I proposal preparation periods are prohibited for reasons of competitive fairness.

b. Requests for Copies of DoD SBIR Solicitation. *To remain on the DoD SBIR Mailing list, send in the Mailing List form (Reference E) to DTIC.* Additional copies of this solicitation may be ordered from:

Defense Technical Information Center
Attn: DTIC/SBIR
8725 John J Kingman Rd, Suite 0944
Ft. Belvoir, VA 22060-6218
(800) 363-7247 (800 DOD-SBIR)

This solicitation is also available on floppy diskette (in Word Perfect) from DTIC for a nominal processing fee. DoD SBIR and STTR solicitations can be access via Internet through DTIC and NTTC.

DTIC	www	http://www.dtic.dla.mil/dtic.sbir
	gopher	gopher.dtic.dla.mil
	ftp	asc.dtic.dla.mil
NTTC	www	http://www.nttc.edu
	ftp/telnet	iron.nttc.edu

It can also be obtained electronically using Business Gold, the National Technology Transfer Center's bulletin board system. Connect by dialing (304) 243-2560 for high speed modems (9600+) or (304) 243-2561 for 1200-2400 baud modems and logging in as guest. For more information on the NTTC electronic bulletin board system contact:

National Technology Transfer Center
Wheeling Jesuit College
316 Washington Ave
Wheeling, WV 26003
(800) 678-6882

c. Outreach Program. The DoD holds three National SBIR Conferences a year and participates in many state-organized conferences for small business. We have a special outreach effort to socially and economically and disadvantaged firms and to small companies that are negatively affected by the Defense down-sizing.

2.0 DEFINITIONS

The following definitions apply for the purposes of this solicitation:

2.1 Research or Research and Development

Basic Research - Scientific study and experimentation to provide fundamental knowledge required for the solution of problems.

Exploratory Development - A study, investigation or minor development effort directed toward specific problem areas with a view toward developing and evaluating the feasibility and practicability of proposed solutions.

Advanced Development - Proof of design efforts directed toward projects that have moved into the development of hardware for test.

Engineering Development - Full-scale engineering development projects for DoD use but which have not yet received approval for production.

2.2 Small Business

A small business concern is one that, at the time of award of a Phase I or Phase II contract:

a. Is independently owned and operated and organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States;

b. Is at least 51% owned, or in the case of a publicly owned business, at least 51% of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens;

c. Has, including its affiliates, a number of employees not exceeding 500, and meets the other regulatory requirements found in 13 CFR 121. Business concerns, other than investment companies licensed, or state development companies qualifying under the Small Business Investment Act of 1958, 15 USC 661, et seq., are affiliates of one another when either directly or indirectly (1) one concern controls or has the power to control the other; or (2) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and contractual relationships. The term "affiliates" is defined in greater detail in 13 CFR 121.3-2(a). The term "number of employees" is defined in 13 CFR 121.3-2(t). Business concerns include, but are not limited to, any individual, partnership, corporation, joint venture, association or cooperative.

2.3 Socially and Economically Disadvantaged Small Business

A small business that is at the time of award of a Phase I or Phase II contract:

a. At least 51% owned by an Indian tribe or a native Hawaiian organization, or one or more socially and economically disadvantaged individuals, and

b. Whose management and daily business operations are controlled by one or more socially and economically disadvantaged individuals.

A socially and economically disadvantaged individual is defined as a member of any of the following groups: Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent-Asian Americans, or other groups designated by SBA to be socially disadvantaged.

2.4 Women-Owned Small Business

A women-owned small business is one that is at least 51% owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" in this context means being actively involved in the day-to-day

management.

2.5 Funding Agreement

Any contract, grant, or cooperative agreement entered into between any federal agency and any small business concern for the performance of experimental, developmental, or research work funded in whole or in part by the federal government. *Only the contract method will be used by DoD components for all SBIR awards.*

2.6 Subcontract

A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Government contract awardee calling for supplies or services required solely for the performance of the original contract. This includes consultants.

2.7 Commercialization

The process of developing markets and producing and delivering products for sale (whether by the originating party or by others); as used here, commercialization includes both government and private sector markets.

3.0 PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

3.1 Proposal Requirements

A proposal to any DoD Component under the SBIR Program is to provide sufficient information to persuade the DoD Component that the proposed work represents an innovative approach to the investigation of an important scientific or engineering problem and is worthy of support under the stated criteria.

The quality of the scientific or technical content of the proposal will be the principal basis upon which proposals will be evaluated. The proposed research or research and development must be responsive to the chosen topic. Any small business contemplating a bid for work on any specific topic should determine that (a) the technical approach has a reasonable chance of meeting the topic objective, (b) this approach is innovative, not routine, and (c) the firm has the capability to implement the technical approach, i.e. has or can obtain people and equipment suitable to the task.

Those responding to this solicitation should note the proposal preparation tips listed below:

- Read and follow all instructions contained in this solicitation.
- Use the free technical information services from DTIC and other information assistance organizations (Section 7.1 - 7.4).
- Mark proprietary information as instructed in Section 5.5.
- Limit your proposal to 25 pages (excluding company commercialization report).
- Use a type size no smaller than 12 pitch or 11 point.
- Don't include proprietary or classified information in the project summary (Appendix B).
- Include a Red Copy of Appendix A and Appendix B as part of the Original of each proposal.
- Do not use a proportionally spaced font on Appendix A and Appendix B.
- Include a company commercialization report, where required, listing all SBIR Phase I and Phase II projects and the commercialization status of Phase II projects (see details in Section 3.4.n).

3.2 Proprietary Information

If information is provided which constitutes a trade secret, proprietary, commercial or financial information, confidential personal information, or data affecting the national security, it will be treated in confidence to the extent permitted by law, provided it is clearly marked in accordance with Section 5.5.

3.3 Limitations on Length of Proposal

This solicitation is designed to reduce the investment of time and cost to small firms in preparing a formal proposal. Those who wish to respond must submit a direct, concise, and informative research or research and development proposal of no more than 25 pages, excluding commercialization record summary, (no type smaller than 11 point or 12 pitch on standard 8½" X 11" paper with one (1) inch margins, 6 lines per inch), *including Proposal Cover Sheet (Appendix A), Project Summary (Appendix B), Cost Proposal (Appendix C), and any enclosures or attachments.* Promotional and non-project related discussion is discouraged. Cover all items listed below in Section 3.4 in the order given. The space allocated to each will depend on the problem chosen and the principal investigator's approach. In the interest of equity, proposals in excess of the 25-page limitation (including attachments, appendices, or references, but excluding commercialization record summary) <u>will not</u> be considered for review or award.

3.4 Phase I Proposal Format

All pages shall be consecutively numbered and the ORIGINAL of each proposal must contain a completed red copy of Appendix A and Appendix B.

a. Cover Sheet. Complete RED COPY of Appendix A, photocopy the completed form, and use a copy as Page 1 of each additional copy of your proposal.

b. Project Summary. Complete RED COPY of Appendix B, photocopy the completed form, and use a copy as Page 2 of each additional copy of your proposal. The technical abstract should include a brief description of the project objectives and description of the effort. Anticipated benefits and commercial applications of the proposed research or research and development should also be summarized in the space provided. The Project Summaries of proposals selected for award will be publicly released on the Internet and, therefore, should not contain proprietary or classified information.

c. Identification and Significance of the Problem or Opportunity. Define the specific technical problem or opportunity addressed and its importance. (Begin on Page 3 of your proposal.)

d. Phase I Technical Objectives. Enumerate the specific objectives of the Phase I work, including the questions it will try to answer to determine the feasibility of the proposed approach.

e. Phase I Work Plan. Provide an explicit, detailed description of the Phase I approach. The plan should indicate what is planned, how and where the work will be carried out, a schedule of major events, and the final product to be delivered. Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal.

f. Related Work. Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, the proposing firm, consultants, or others. Describe how these activities interface with the proposed project and discuss any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic.

Describe previous work not directly related to the proposed effort but similar. Provide the following: (1) short description, (2) client for which work was performed (including individual to be contacted and phone number), and (3) date of completion.

g. Relationship with Future Research or Research and Development.

(1) State the anticipated results of the proposed approach if the project is successful.

(2) Discuss the significance of the Phase I effort in providing a foundation for Phase II research or research and development effort.

h. Potential Post Applications. Describe, in approximately one page, your company's strategy for converting your proposed SBIR research into a product or products with widespread commercial use in private sector and/or military markets.

i. Key Personnel. Identify key personnel who will be involved in the Phase I effort including information on directly related education and experience. A concise resume of the principal investigator, including a list of relevant publications (if any), must be included.

j. Facilities/Equipment. Describe available instrumentation and physical facilities necessary to carry out the Phase I effort. Items of equipment to be purchased (as detailed in Appendix C) shall be justified under this section. Also state whether or not the facilities where the proposed work will be performed meet environmental laws and regulations of federal, state (name) and local governments for, but not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulk waste disposal practices, and handling and storage of toxic and hazardous materials.

k. Consultants. Involvement of university or other consultants in the project may be appropriate. If such involvement is intended, it should be described in detail and identified in Appendix C. A minimum of two-thirds of each Phase I SBIR project must be carried out by the proposing firm, unless otherwise approved in writing by the contracting officer.

l. Prior, Current, or Pending Support of Similar Proposals or Awards. *Warning* -- While it is permissible, with proposal notification, to submit identical proposals or proposals containing a significant amount of essentially equivalent work for consideration under numerous federal program solicitations, it is unlawful to enter into contracts or grants requiring essentially equivalent effort. If there is any question concerning this, it must be disclosed to the solicitating agency or agencies before award.

If a proposal submitted in response to this solicitation is substantially the same as another proposal that has been funded, is now being funded, or is pending with another federal agency or DoD Component or the same DoD Component, the proposer must indicate action on Appendix A and provide the following information:

(1) Name and address of the federal agency(s) or DoD Component to which a proposal was submitted, will be submitted, or from which an award is expected or has been received.
(2) Date of proposal submission or date of award.
(3) Title of proposal.
(4) Name and title of principal investigator for each proposal submitted or award received.
(5) Title, number, and date of solicitation(s) under which the proposal was submitted, will be submitted, or under which award is expected or has been received.
(6) If award was received, state contract number.
(7) Specify the applicable topics for each SBIR proposal submitted or award received.

Note: If Section 3.4.1 does not apply, state in the proposal "No prior, current, or pending support for proposed work."

m. Cost Proposal. Complete the cost proposal in the form of Appendix C for the Phase I effort only. Some items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item. What matters is that enough information be provided to allow the DoD Component to understand how the proposer plans to use the requested funds if the contract is awarded.

(1) List all key personnel by name as well as by number of hours dedicated to the project as direct labor.
(2) Special tooling and test equipment and material cost may be included under Phases I and II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the government and should be related directly to the specific topic. These may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the government or acquired with government funds will be vested with the DoD Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DoD Component.
(3) Cost for travel funds must be justified and related to the needs of the project.
(4) Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a Phase I proposal.

n. Company Commercialization Report of Prior SBIR Awards. For Phase I proposals, if the small business concern has received more than 15 Phase II awards in the prior 5 fiscal years, it must submit a Company Commercialization Report that:

(1) lists the name of awarding agency, date of award, contract number, topic or subtopic, title, and award amount for each Phase I and Phase II project, and
(2) lists, for each Phase II project,
    (a) the sources and amounts of non-SBIR funding received for Phase III, and
    (b) the revenue from sales of new products in Phase III.

    Apportion the Phase III funding and sales revenue amoung the various Phase II products without double-counting.

All Phase II proposals must include a Company Commercialization Report. (This required proposal information shall not be counted toward proposal pages count limitations.)

3.5 Bindings

Do not use special bindings or cover. Staple the pages in the upper left hand corner of each proposal.

3.6 Phase II Proposal

This solicitation is for Phase I only. A Phase II proposal can be submitted only by a Phase I awardee and only in response to a request from the agency; that is, Phase II is not initiated by a solicitation. Each proposal must contain a Red Cover Sheet (Appendix A), a Red Project Summary Sheet (Appendix B), and a Company Commercialization Report (see Section 3.4.n) regardless of the number of Phase II awards received. Copies of Appendices along with instructions regarding Phase II proposal preparation and submission will be provided by the DoD Components to all Phase I winners at time of Phase I contract award.

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.1 Introduction

Phase I proposals will be evaluated on a competitive basis and will be considered to be binding for six (6) months from the date of closing of this solicitation unless offeror states otherwise. If selection has not been made prior to the proposal's expiration date, offerors will be requested as to whether or not they want to extend their proposal for an additional period of time. Proposals meeting stated solicitation requirements will be evaluated by scientists or engineers knowledgeable in the topic area. Proposals will be evaluated first on their relevance to the

chosen topic. Those found to be relevant will then be evaluated using the criteria listed in Section 4.2. Final decisions will be made by the DoD Component based upon these criteria and consideration of other factors including possible duplication of other work, and program balance. A DoD Component may elect to fund several or none of the proposed approaches to the same topic. In the evaluation and handling of proposals, every effort will be made to protect the confidentiality of the proposal and any evaluations. There is no commitment by the DoD Components to make any awards on any topic, to make a specific number of awards or to be responsible for any monies expended by the proposer before award of a contract.

For proposals that have been selected for contract award, a Government Contracting Officer will draw up an appropriate contract to be signed by both parties before work begins. Any negotiations that may be necessary will be conducted between the offeror and the Government Contracting Officer. It should be noted that only a duly appointed contracting officer has the authority to enter into a contract on behalf of the U.S. Government.

Phase II proposals will be subject to a technical review process similar to Phase I. Final decisions will be made by DoD Components based upon the scientific and technical evaluations and other factors, including a commitment for Phase III follow-on funding, the possible duplication with other research or research and development, program balance, budget limitations, and the potential of a successful Phase II effort leading to a product of continuing interest to DoD.

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors on their proposals.

4.2 Evaluation Criteria - Phase I

The DoD Components plan to select for award those proposals offering the best value to the government and the nation considering the following factors.

- **a.** The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution
- **b.** The potential for commercial (government or private sector) application and the benefits expected to accrue from this commercialization
- **c.** The adequacy of the proposed effort for the fulfillment of requirements of the research topic
- **d.** The qualifications of the proposed principal/key investigators supporting staff and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

Technical reviewers will base their conclusions only on information contained in the proposal. It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referenced experiments. Relevant supporting data such as journal articles, literature, including government publications, etc., should be contained or referenced in the proposal.

4.3 Evaluation Criteria - Phase II

The Phase II proposal will be reviewed for overall merit based upon the criteria below.

- **a.** The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution
- **b.** The potential for commercial (government or private sector) application and the benefits expected to accrue from this commercialization
- **c.** The adequacy of the proposed effort for the fulfillment of requirements of the research topic
- **d.** The qualifications of the proposed principal/key investigators supporting staff and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

The reasonableness of the proposed costs of the effort to be performed will be examined to determine those proposals that offer the best value to the government. Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

The follow-on funding commitment must provide that a specific amount of Phase III funds will be made available to or by the small business and indicate the dates the funds will be made available. It must also contain specific technical objectives which, if achieved in Phase II, will make the commitment exercisable by the small business. The terms cannot be contingent upon the obtaining of a patent due to the length of time this process requires. The funding commitment shall be submitted with the Phase II proposal.

Phase II proposal evaluation may include on-site evaluations of the Phase I effort by government personnel.

4.4 Assessing Commercial Potential of Proposals

A Phase I or Phase II proposal's commercial potential can be evidenced by:

(1) the small business concern's record of commercializing SBIR or other research (see Company Commercialization Report, Section 3.4.n),

(2) the existence of second phase funding commitments from private sector or non-SBIR funding sources,

(3) the existence of third phase follow-on commitments for

the subject of the research, or

(4) the presence of other indicators of commercial potential of the idea.

4.5 SBIR Fast Track

a. In General. On a two-year pilot basis, beginning with this solicitation, the DoD SBIR program will implement a fast-track SBIR process for companies which, during their Phase I projects, attract independent third-party investors that will match both phase II SBIR funding and interim SBIR funding (between Phases I and II). As discussed in detail below, companies which obtain such third-party matching funds and thereby qualify for the SBIR fast track will receive (subject to the qualifications described herein):

(1) Interim funding on the order of $40,000 (generally, $30,000 to $50,000) between Phases I and II;

(2) The Department's highest priority for Phase II SBIR funding; and

(3) An expedited Phase II selection decision and, upon selection, an expedited Phase II award.

b. How To Qualify for the SBIR Fast Track. To qualify for the SBIR fast track, a company must submit the following items, within 120 days after the start of its Phase I project, to the same address the company would send its Phase II proposal (see back of Appendix D):

(1) A completed fast-track application form, found at Appendix D. (Please also send a copy to OSD SBIR -- see back of Appendix D.)

(2) A commitment letter from an independent third-party investor -- such as another company, a venture capital firm, an "angel" investor, or a non-SBIR government program -- indicating that the third-party investor will match both interim and Phase II SBIR funding, in cash, contingent upon the company's receipt of interim and Phase II SBIR funds.

The matching rates are as follows:

(a) For companies that have 10 or fewer employees and have never received a Phase II SBIR award from DoD or any other federal agency, the minimum matching rate is 25 cents for every SBIR dollar. (For example, if such a company receives an interim SBIR award of $40,000 and a Phase II award of $750,000, it must obtain matching funds of $10,000 and $187,500 respectively for the two awards.)

(b) For companies that have received 5 or more Phase II SBIR awards from the federal government (including DoD), the minimum matching rate is 1 dollar for every SBIR dollar. (For example, if such a company receives an interim SBIR award of $40,000 and a Phase II award of $750,000, it must obtain matching funds of $40,000 and $750,000 respectively for the two awards.)

(c) For all other companies, the minimum matching rate is 50 cents for every SBIR dollar. (For example, if such a company receives an interim SBIR award of $40,000 and a Phase II award of $750,000, it must obtain matching funds of $20,000 and $375,000 respectively for the two awards.)

The commitment letter should indicate that the third-party funds will pay for work that is connected to the particular SBIR project, and should describe the general nature of that work. The work funded by the third-party investor may be additional research and development on the project or, alternatively, it may be other activity related to the project (e.g., marketing) that is outside the scope of the SBIR contract.

(3) A concise statement of work for the interim SBIR effort (if an interim option was not previously negotiated on the Phase I contract). This statement of work should be under 4 pages in length.

(4) A concise report on the status of the Phase I project, if required by the DoD component that is funding the project. This report should be under 4 pages in length.

In addition:

(1) The company must submit its Phase II proposal no later than 30 days prior to completion of its Phase I project, unless a different deadline for fast-track Phase II proposals is specified in the Phase II proposal instructions of the sponsoring DoD component.

(2) If the company receives an interim and/or Phase II SBIR award from DoD, its matching funds must arrive before corresponding installments of SBIR funds are released. For example, a company whose matching rate is 50 cents to the dollar must certify, to the satisfaction of its DoD contracting officer, that it has received $20,000 in cash from the third-party investor before the contracting officer will release $40,000 in interim SBIR funds. Similarly, the company must certify that it has received $30,000 in third-party funds before the contracting officer will release a $60,000 installment of phase II funds. (A simple letter stating

that the third-party funds have arrived, with an attached copy of the bank statement, should generally suffice.)

Failure to meet these conditions in their entirety and within the time frames indicated will disqualify a company from participation in the SBIR fast track. The company will still be eligible to compete for a Phase II SBIR award through the regular procedures.

c. Benefits of Qualifying for the Fast Track. A company which qualifies for the fast track will:

(1) Receive interim SBIR funding on the order of $40,000 (generally, $30,000 to $50,000), commencing at the end of Phase I.

Note: It is DoD policy that the vast majority of Phase I contracts which qualify for the fast track will receive interim SBIR funding. However, the DoD contracting office has the discretion and authority, in any particular instance, to deny interim funding to a Phase I contractor when doing so is in the government's interest (e.g., when the project no longer meets a military need).

(2) Receive the Department's highest priority for Phase II award. Specifically, it is DoD policy that the percentage of fast-track Phase I projects which receive Phase II awards will be significantly higher than the overall percentage of Phase I projects which receive Phase II awards. (Historically, roughly one-third of Phase I projects at DoD receive Phase II awards.)

(3) Receive notification of whether it has been selected for a Phase II award, within an average of two months -- and, in all cases, no longer than ten weeks -- after the completion of its Phase I project.

(4) If selected, receive its Phase II award within an average of five months from the completion of its Phase I project.

5.0 CONTRACTUAL CONSIDERATIONS

Note: Eligibility and Limitation Requirements (Section 1.4) Will Be Enforced

5.1 Awards (Phase I)

a. Number of Phase I Awards. The number of Phase I awards will be consistent with the agency's RDT&E budget, the number of anticipated awards for interim Phase I modifications, and the number of anticipated Phase II contracts. No Phase I contracts will be awarded until all qualified proposals (received in accordance with Section 6.2) on a specific topic have been evaluated. All proposers will be notified of selection/non-selection status for a Phase I award no later than January 1, 1996. The name of those firms selected for awards will be announced. *The DoD Components anticipate making 460 Phase I awards from this solicitation.* On average, 1 in 8 Phase I proposals receive funding.

b. Type of Funding Agreement. All winning proposals will be funded under negotiated contracts and may include a fee or profit. The firm fixed price or cost plus fixed fee type contract will be used for all Phase I projects (see Section 5.4). *Note: The firm fixed price contract is the preferred type for Phase I.*

c. Average Dollar Value of Awards. DoD Components will make Phase I awards to small businesses typically on a one-half person-year effort over a period generally not to exceed six months (subject to negotiation). PL 102-564 allows agencies to award Phase I contracts up to $100,000 without justification. Where applicable, specific funding instructions are contained in Section 8 for each DoD Component.

5.2 Awards (Phase II)

a. Number of Phase II Awards. The number of Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. *The DoD Components anticipate that approximately 40 percent of its Phase I awards will result in Phase II projects.*

b. Type of Funding Agreement. Each Phase II proposal selected for award will be funded under a negotiated contract and may include a fee or profit.

c. Project Continuity. Phase II proposers who wish to maintain project continuity must submit proposals no later than 30 days prior to the expiration date of the Phase I contract and must identify in their proposal the work to be performed for the first four months of the Phase II effort and the costs associated therewith. *These Phase II proposers may be issued a modification to the Phase I contract, at the discretion of the government,* covering an interim period not to exceed four months for preliminary Phase II work while the total Phase II proposal is being evaluated and a contract is negotiated. This modification would normally become effective at the completion of

Phase I or as soon thereafter as possible. Funding, scope of work, and length of performance for this interim period will be subject to negotiations. Issuance of a contract modification for the interim period does not commit the government to award a Phase II contract. <u>See special instructions for each DoD Component in Section 8.</u> *(For Phase I projects which qualify for the SBIR Fast Track, the instructions in Secion 4.5 supercede those in this paragraph.)*

d. Average Dollar Value of Awards. Phase II awards will be made to small businesses based on results of the Phase I efforts and the scientific, technical, and commercial merit of the Phase II proposal. Average Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). PL 102-564 states that the Phase II awards may be up to $750,000 each without justification. <u>See special instructions for each DoD Component in Section 8.</u>

5.3 Reports

a. Content. A final report is required for each Phase I project. The report must contain in detail the project objectives, work performed, results obtained, and estimates of technical feasibility. A completed SF 298, "Report Documentation Page", will be used as the first page of the report. In addition, Monthly status and progress reports may be required by the DoD agency. (A blank SF 298 is provided in Section 9.0, Reference D.)

b. Preparation.

(1) To avoid duplication of effort, language used to report Phase I progress in a Phase II proposal, if submitted, may be used verbatim in the final report with changes to accommodate results after Phase II proposal submission and modifications required to integrate the final report into a self-contained comprehensive and logically structured document.

(2) Block 12a (Distribution/Availability Statement) of the SF298, "Report Documentation Page" in each unclassified final report must contain one of the following statements:
   (a) Approved for public release; distribution unlimited.
   (b) Distribution authorized to U.S. Government Agencies only; contains proprietary information.

(3) Block 13 (Abstract) of the SF 298, "Report Documentation Page") must include as the first sentence, "<u>Report developed under SBIR contract</u>". The abstract must identify the purpose of the work and briefly describe the work carried out, the finding or results and the potential applications of the effort. Since the abstract will be published by the DoD, it must not contain any proprietary or classified data.

(4) Block 14 (Subject Terms) of the SF 298 must include the term "SSBIR Report".

c. Submission. <u>SIX COPIES</u> of the final report on each Phase I project shall be submitted to the DoD in accordance with the negotiated delivery schedule. Delivery will normally be within thirty days after completion of the Phase I technical effort. One copy of each unclassified report shall be delivered directly to the DTIC, ATTN: Document Acquisition, 8725 John J Kingman Road, Suite 0944, Ft. Belvoir, VA 22060-6218.

5.4 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon completion of negotiations between the DoD and the successful Phase I or Phase II offeror. Successful offerors may be paid periodically as work progresses in accordance with the negotiated price and payment schedule. Phase I contracts are primarily fixed price contracts, under which monthly progress payments may be made up to 90% of the contract price excluding fee or profit. The contract may include a separate provision for payment of a fee or profit. Final payment will follow completion of contract performance and acceptance of all work required under the contract. Other types of financial assistance may be available under the contract.

5.5 Markings of Proprietary or Classified Proposal Information

The proposal submitted in response to this solicitation may contain technical and other data which the proposer does not want disclosed to the public or used by the government for any purpose other than proposal evaluation.

Information contained in unsuccessful proposals will remain the property of the proposer except for Appendices A and B. The government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information is provided by a proposer in a proposal which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security, it will be treated in confidence, to the extent permitted by law, provided this information is clearly marked by the proposer with the term "confidential proprietary information" and provided that the following legend which appears on the title page (Appendix A) of the proposal is completed:

> "For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to the proposer as a result of or in connection with the submission of this data, the government shall have

the right to duplicate, use or disclose the data to the extent provided in the contract. This restriction does not limit the government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s)________of this proposal."

Any other legend may be unacceptable to the government and may constitute grounds for removing the proposal from further consideration and without assuming any liability for inadvertent disclosure. The government will limit dissemination of properly marked information to within official channels.

In addition, each page of the proposal containing proprietary data which the proposer wishes to restrict must be marked with the following legend:

"Use or disclosure of the proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the cover page of this proposal."

The government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event properly marked data contained in a proposal in response to this solicitation is requested pursuant to the Freedom of Information Act, 5 USC 552, the proposer will be advised of such request and prior to such release of information will be requested to expeditiously submit to the DoD Component a detailed listing of all information in the proposal which the proposer believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the proposer will ensure that any information released by the DoD Component pursuant to the Act is properly determined.

Those proposers that have a classified facility clearance may submit classified material with their proposal. Any classified material shall be marked and handled in accordance with applicable regulations. Arbitrary and unwarranted use of this restriction is discouraged. Offerors must follow the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M) procedures for marking and handling classified material.

5.6 Copyrights

To the extent permitted by statute, the awardee may copyright (consistent with appropriate national security considerations, if any) material developed with DoD support. DoD receives a royalty-free license for the Federal Government and requires that each publication contain an appropriate acknowledgement and disclaimer statement.

5.7 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with government support. The government receives a royalty-free license for its use, reserves the right to require the patent holder to license others in certain limited circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the government will not make public any information disclosing a government-supported invention for a period of five years to allow the awardee to pursue a patent.

5.8 Technical Data Rights

Rights in technical data, including software, developed under the terms of any contract resulting from proposals submitted in response to this solicitation generally remain with the contractor, except that the government obtains a royalty-free license to use such technical data only for government purposes during the period commencing with contract award and ending five years after completion of the project under which the data were generated. Upon expiration of the five-year restrictive license, the government has unlimited rights in the SBIR data. During the license period, the government may not release or disclose SBIR data to any person other than its support services contractors except: (1) For evaluational purposes; (2) As expressly permitted by the contractor; or (3) A use, release, or disclosure that is necessary for emergency repair or overhaul of items operated by the government. See FAR clause 52.227-20, "Rights in Data - SBIR Program" and DFARS 252.227-7018, "Rights in Noncommercial Technical Data and Computer Software -- SBIR Program."

5.9 Cost Sharing

Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of any Phase I proposal.

5.10 Joint Ventures or Limited Partnerships

Joint ventures and limited partnerships are eligible provided the entity created qualifies as a small business as defined in Section 2.2 of this solicitation.

5.11 Research and Analytical Work

a. For Phase I a minimum of two-thirds of the research and/or analytical effort must be performed by the proposing firm unless otherwise approved in writing by the contracting officer.

b. For Phase II a minimum of one-half of the research and/or analytical effort must be performed by the proposing firm, unless otherwise approved in writing by the contracting officer.

5.12 Contractor Commitments

Upon award of a contract, the contractor will be required to make certain legal commitments through acceptance of government contract clauses in the Phase I contract. The outline that follows is illustrative of the types of provisions required by the Federal Acquisition Regulations that will be included in the Phase I contract. This is not a complete list of provisions to be included in Phase I contracts, nor does it contain specific wording of these clauses. Copies of complete general provisions will be made available prior to award.

a. Standards of Work. Work performed under the contract must conform to high professional standards.

b. Inspection. Work performed under the contract is subject to government inspection and evaluation at all reasonable times.

c. Examination of Records. The Comptroller General (or a fully authorized representative) shall have the right to examine any directly pertinent records of the contractor involving transactions related to this contract.

d. Default. The government may terminate the contract if the contractor fails to perform the work contracted.

e. Termination for Convenience. The contract may be terminated at any time by the government if it deems termination to be in its best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

f. Disputes. Any dispute concerning the contract which cannot be resolved by agreement shall be decided by the contracting officer with right of appeal.

g. Contract Work Hours. The contractor may not require an employee to work more than eight hours a day or forty hours a week unless the employee is compensated accordingly (that is, receives overtime pay).

h. Equal Opportunity. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

i. Affirmative Action for Veterans. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam era.

j. Affirmative Action for Handicapped. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

k. Officials Not to Benefit. No member of or delegate to Congress shall benefit from the contract.

l. Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation except bona fide employees or commercial agencies maintained by the contractor for the purpose of securing business.

m. Gratuities. The contract may be terminated by the government if any gratuities have been offered to any representative of the government to secure the contract.

n. Patent Infringement. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

o. Military Security Requirements. The contractor shall safeguard any classified information associated with the contracted work in accordance with applicable regulations.

p. American Made Equipment and Products. When purchasing equipment or a product under the SBIR funding agreement, purchase only American-made items whenever possible.

5.13 Additional Information

a. General. This Program Solicitation is intended for information purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

b. Small Business Data. Before award of an SBIR contract, the government may request the proposer to submit certain organizational, management, personnel, and financial information to confirm responsibility of the proposer.

c. Proposal Preparation Costs. The government is not responsible for any monies expended by the proposer before award of any contract.

d. Government Obligations. This Program Solicitation is not an offer by the government and does not obligate the government to make any specific number of

awards. Also, awards under this program are contingent upon the availability of funds.

e. Unsolicited Proposals. The SBIR Program is not a substitute for existing unsolicited proposal mechanisms. Unsolicited proposals will not be accepted under the SBIR Program in either Phase I or Phase II.

f. Duplication of Work. If an award is made pursuant to a proposal submitted under this Program Solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by an agency of the Federal Government.

g. Classified Proposals. If classified work is proposed or classified information is involved, the offeror to the solicitation must have, or obtain, security clearance in accordance with the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M).

6.0 SUBMISSION OF PROPOSALS

An original plus (4) copies of each proposal or modification will be submitted, in a single package, as described below, unless otherwise stated by specific instructions in Section 8.0.

NOTE: THE ORIGINAL OF EACH PROPOSAL MUST CONTAIN A COMPLETED RED COPY OF APPENDIX A (COVER SHEET) AND APPENDIX B (PROJECT SUMMARY), AND A COMPANY COMMERCIALIZATION REPORT, WHERE REQUIRED (see Section 3.4.n).

6.1 Address

Each proposal or modification package must be addressed to that DoD Component address which is identified for the specific topic in that Component's subsection of Section 8.0 to this solicitation.

The name and address of the offeror, the solicitation number and the topic number for the proposal must be clearly marked on the face of the envelope or wrapper.

Mailed or handcarried proposals must be delivered to the address indicated for each topic. Secured packaging is mandatory. The DoD Component cannot be responsible for the processing of proposals damaged in transit.

All copies of a proposal must be sent in the same package. Do not send separate information copies or several packages containing parts of the single proposal.

6.2 Deadline of Proposals

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time, January 5, 1996. Any proposal received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before an award is made, and: (a) it was sent by registered or certified mail not later than December 29, 1995 or (b) it was sent by mail and it is determined by the government that the late receipt was due solely to mishandling by the government after receipt at the government installation.

Note: There are no other provisions for late receipt of proposals under this solicitation.

The only acceptable evidence to establish (a) the date of mailing of a late-received proposal sent either by registered mail or certified mail is the U. S. Postal Service postmark on the wrapper or on the original receipt from the U. S. Postal Service. If neither postmark shows a legible date, the proposal shall be deemed to have been mailed late. The term postmark means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed on the date of mailing by employees of the U. S. Postal Service. Therefore, offerors should request the postal clerk to place a hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper; (b) the time of receipt at the government installation is the time-date stamp of such installation on the proposal wrapper or other documentary evidence of receipt maintained by the installation.

Proposals may be withdrawn by written notice or a telegram received at any time prior to award. Proposals may also be withdrawn in person by an offeror or his authorized representative, provided his identity is made known and he signs a receipt for the proposal. (NOTE: the term telegram includes mailgrams.)

Any modification or withdrawal of a proposal is subject to the same conditions outlined above. Any modification may not make the proposal longer than 25 pages (excluding company commercialization record). Notwithstanding the above, a late modification of an otherwise successful proposal which makes its terms more favorable to the government will be considered at any time it is received and may be accepted.

6.3 Notification of Proposal Receipt

Proposers desiring notification of receipt of their proposal must complete and include a self-addressed stamped envelope and a copy of the notification form (Reference A) in the back of this brochure. If multiple

proposals are submitted, a separate form and envelope is required for each. Notification of receipt of a proposal by the government does not by itself constitute a determination that the proposal was received on time or not. The determination of timeliness is solely governed by the criteria set forth in Section 6.2.

6.4 Information on Proposal Status

Evaluation of proposals and award of contracts will be expedited, but no information on proposal status will be available until the final selection is made. However, contracting officers may contact any and all qualified proposers prior to contract award.

6.5 Debriefing of Unsuccessful Offerors

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors for their proposals.

6.6 Correspondence Relating to Proposals

All correspondence relating to proposals should cite the SBIR solicitation number and specific topic number and should be addressed to the DoD Component whose address is associated with the specific topic number.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

7.1 DoD Technical Information Services Available

Recognizing that small businesses may not have strong technical information service support, the Defense Technical Information Center (DTIC) gives special attention to the needs of DoD SBIR Program participants. DTIC information support assists firms preparing SBIR and other R&D proposals to DoD in making informed bid decisions and technically stronger submittals.

DTIC, a major component of the DoD Scientific and Technical Information Program, serves DoD and other federal agencies and their contractors by managing and providing technical information resulting from and describing DoD-funded research and development.

DTIC also provides access to specialized reference services and subject matter expertise within the DoD-sponsored Centers for Analysis of Scientific and Technical Information (IACs), which are concerned with engineering, technical and scientific documents and databases worldwide.

For the majority of SBIR topics, DTIC prepares a Technical Information Package (TIP), containing a bibliographic listing of DoD-funded work in technical areas related to the topic. Many TIPs also include information provided by the topic author and references to other information sources.

Firms responding to this solicitation are encouraged to use Reference B at the back of this solicitation to request TIPs covering their proposal topic areas. Requests may also be submitted by telephone, fax, or email. In addition, TIPs are available online via the DTIC SBIR Home Page on Internet.

DTIC will return requested material, along with a user code for use in obtaining additional information or technical reports. In support of SBIR proposal preparation, up to ten technical reports may be ordered at no cost from DTIC during a soliciation period.

Online services, accessed via the DTIC Home Page (http://www.dtic.dla.mil/dtic/sbir), include TIPs as well as current DoD SBIR and STTR solicitations and award abstracts publications. Solicitation and awards information is also accessible via gopher (gopher.dtic.dla.mil) on port 70, or file transfer (asc.dtic.dla.mil). The FTP login is "anonymous", password is your E-Mail address, SBIR files are in the /pub/sbir directory. Also on Internet is SITIS for technical questions and answers concerning DoD topic descriptions. See section 7.2 for a complete description of this important service.

Call, or visit (by prearrangement) DTIC at the location most convenient to you. Written communications must be made to the Ft. Belvoir, Va., address.

Defense Technical Information Center
ATTN: DTIC-SBIR
8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218
(800) 363-7247 (800 DOD-SBIR)
(703) 767-8228 (FAX)
EMail sbir@dtic.dla.mil
WWW http://www.dtic.dla.mil/dtic/sbir

DTIC Boston Regional Office
Building 1103, 5 Wright Street
Hanscom AFB
Bedford, MA 01731-5000
(617) 377-2413

DTIC Albuquerque Regional Office
PL/SUL
3550 Aberdeen Ave, SE
Kirtland AFB, NM 87117-6008
(505) 846-6797

DTIC Dayton Regional Office
2690 C Street, Suite 4
Wright-Patterson AFB, OH 45433-7552
(513) 255-7905

DTIC Los Angeles Regional Office
222 N. Sepulveda Blvd., Suite 906
El Segundo, CA 90245-4320
(310) 335-4170

7.2 SBIR Interactive Topic Information System (SITIS)

Small businesses may ask technical questions about the solicitation topics in Section 8 by using the DTIC/MATRIS SBIR Interactive Topic Information System (SITIS), an anonymous electronic forum between participant small businesses and the DoD scientists and engineers assigned to SBIR topics. SITIS should not be used to ask general questions about the program or solicitation, which instead should be directed to (800) 382-4634.

SITIS is accessible through the World Wide Web at: **http://dticam.dtic.dla.mil/www/sbir/sbir.html** (you can link to SITIS using Mosaic, Netscape, etc.). Technical questions about solicitation topics can also be submitted via e-mail, fax, paper mail, or telephone by contacting the SBIR Coordinator at:

Defense Technical Information Center
MATRIS Office, DTIC-AM
ATTN: SBIR Coordinator
53355 Cole Rd.
San Diego, CA 92152-7213
Phone: (619) 553-7000
Fax: (619) 553-7053
Email: sbir@dticam.dtic.dla.mil
WWW: http://dticam.dtic.dla.mil/www/sbir/sbir.html

SITIS electronically posts all questions and answers by topic number, for general viewing, throughout the pre-solicitation and solicitation period. Answers are generally posted within seven working days of question submission. (Answers will also be emailed or faxed directly to the inquirer if the inquirer provides an email address or fax number.) Questions will be accepted until 30 days before the solicitation closing date.

In addition to managing SITIS, the MATRIS Office also provides information services in the areas of manpower, personnel, training and simulation, human factors, and safety.

7.3 Other Technical Information Assistance Sources

Other sources provide technology search and/or document services and can be contacted directly for service and cost information. These include:

National Technical Information Services
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4600
(703) 321-8547 (FAX)

University of Southern California
Technology Transfer Center
3716 South Hope Street, Suite 200
Los Angeles, CA 90007-4344
(800) 872-7477 (outside CA)
(213) 743-6132
(213) 746-9043 (FAX)

Center for Technology Commercialization
Massachusetts Technology Park
100 North Drive
Westborough, MA 01581
(508) 870-0042
(508) 366-0101 (FAX)

Great Lakes Technology Transfer Center/Battelle
25000 Great Northern Corporate Center, Suite 260
Cleveland, OH 44070
(216) 734-0094
(216) 734-0686 (FAX)

Midcontinent Technology Transfer Center
Texas Engineering Experiment Station
The Texas A&M University System
301 Tarrow, Suite 119
College Station, TX 77843-8000
(409) 845-8762
(409) 845-3559 (FAX)

Mid-Atlantic Technology Applications Center
University of Pittsburgh
823 William Pitt Union
Pittsburgh, PA 15260
(800) 257-2725
(412) 648-7000
(412) 648-7003 (FAX)

Southern Technology Application Center
University of Florida, College of Engineering
Box 24, One Progress Boulevard
Alachua, FL 32615
(904) 462-3913
(800) 225-0308 (outside FL)
(904) 462-3898 (FAX)

Federal Information Exchange, Inc.
555 Quince Orchard Road, Suite 200
Gaithersburg, MD 20878
(301) 975-0103
(301) 975-0109 (FAX)

7.4 DoD Counseling Assistance Available

Small business firms interested in participating in the SBIR Program may seek general administrative guidance from small and disadvantaged business utilization specialists located in various Defense Contract Management activities throughout the continental United States. These specialists are available to discuss general administrative requirements to facilitate the submission of proposals and ease the entry of the small high technology business into the Department of Defense marketplace. The small and disadvantaged business utilization specialists are expressly prohibited from taking any action which would give an offeror an unfair advantage over others, such as discussing or explaining the technical requirements of the solicitation, writing or discussing technical or cost proposals, estimating cost or any other actions which are the offerors responsibility as outlined in this solicitation. (See Reference C at the end of this solicitation for a complete listing, with telephone numbers, of Small and Disadvantaged Business Utilization Specialists assigned to these activities.)

7.5 State Assistance Available

Many states have established programs to provide services to those small firms and individuals wishing to participate in the Federal SBIR Program. These services vary from state to state, but may include:

- Information and technical assistance;
- Matching funds to SBIR recipients;
- Assistance in obtaining Phase III funding.

Contact your State Government Office of Economic Development for further information.

8.0 TECHNICAL TOPICS

Section 8 contains detailed topic descriptions outlining the technical problems for which DoD Components requests proposals for innovative R&D solutions from small businesses. Topics for each participating DoD Component are listed and numbered separately. <u>Each DoD Component Topic Section contains topic descriptions, addresses of organizations to which proposals are to be submitted, and special instructions for preparing and submitting proposals to organizations within the component</u>. Read and follow these instructions carefully to help avoid administrative rejection of your proposal.

Appendices A, B, C and D follow the Component Topic Sections. Appendix A is a red-printed Proposal Cover Sheet, Appendix B is a red-printed Project Summary form, Appendix C is an outline for the Cost Proposal, and Appendix D is the Fast Track Application Form. An original red-printed copy of Appendix A and Appendix B must be included with each proposal submitted.

NAVY
Proposal Submission

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Navy SBIR Program Manager is Mr. Vincent D. Schaper. Inquiries of a general nature may be brought to the Navy SBIR Program Manager's attention and should be addressed to:

Office of Naval Research
ATTN: Mr. Vincent D. Schaper
ONR 362 SBIR
800 North Quincy Street
Arlington, VA 22217-5660
(703) 696-8528

All SBIR proposals written in response to topics in this solicitation **should be submitted to the above address** and must be received by the date and time indicated in Section 6.2 "Deadline Of Proposal" appearing in the front part of this DOD solicitation.

The Navy's SBIR program is a mission-oriented program which integrates the needs and requirements of the Navy primarily through science and technology dual-use, critical technology topics. A total of 31 Science and Technology (S&T) areas has been identified (see Table 1). While all of these areas may not be funded equally during the annual DOD SBIR solicitations in which the Navy participates, topics will be funded according to a priority it has established to meet its mission goals and responsibilities.

This solicitation contains a mix of topics. **Please read the information contained on this page of the solicitation carefully before sending your proposal.** The Navy's part of the solicitation which is readable and retrievable from the INTERNET under the ONR Homepage (address--http://www.onr.navy.mil), contains topics which permit small businesses to submit their solutions to Navy requirements. We are providing proposers the opportunity to send proposals on diskette for this solicitation. From the ONR Homepage on the INTERNET on the SBIR Bulletin Board (address - http://web.fie.com/web/fed/onr/down/onrdn.013.htm), you may "pull down" the Navy part of this DOD solicitation and "pull down" into your computer an SBIR format for filling out your SBIR proposal on disk which can be mailed to the above address together with a single signed hard copy. All proposals sent on disk should be written using one of the following software packages: WordPerfect 5.1, 5.2, 6.0; WordStar 2000 1.0, 2000 2.0, 2000 3.0, 3.3, 3.4, 4.0, 5.0, 6.0, 7.0; MultiMate 4.0; MS Word for Windows 1.0 or 2.0; MS Word 4.0, 5.0 or 6.0; or Display Write 4.0 or 5.0. You may ask technical questions through the SBIR Interactive Topic Information System (SITIS), see Section 7.2 of this solicitation. A listing of companies selected for award negotiations for this Navy SBIR solicitation will be listed on the INTERNET on the Navy SBIR Bulletin Board.

When preparing your proposal keep in mind that Phase I should address the feasibility of the solution to the topic. Be sure that you clearly identify the topic your proposal is addressing. Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which have been invited to submit a Phase II proposal by the Navy technical point of contact (TPOC) during or at the end of successful Phase I effort will be eligible to participate for a Phase II award. All Phase I and Phase II proposals should be sent to the Navy SBIR Program Office (at the above address) for proper processing. Phase III efforts should also be reported to the SBIR program office noted above.

The Navy will provide potential awardees the opportunity to reduce the gap between Phases I & II if they provide a $70,000 maximum feasibility Phase I proposal and a fully costed, well defined ($30,000 maximum) Phase I Option to the Phase I. The Navy will not award Phase I contracts in excess of $70,000 (exclusive of the Phase I option). The Phase I Option should be the initiation of the demonstration phase of the SBIR project (i.e. initial part of Phase II). The Navy will also offer a "fast track" into Phase II to those companies that successfully obtain third party cash partnership funds ("fast track" is described in Section 4.5 of this solicitation). When you submit a Phase II proposal it should consist of three elements: 1) a $600,000 maximum demonstration phase of the SBIR project (i.e. Phase II); 2) a transition or marketing plan (formally called "a commercialization plan") describing how, to whom and at what stage you will market your technology to the government and private sector; 3) a Phase II Option ($150,000 maximum) which would be a fully costed and well defined section describing a test and evaluation plan or further R&D if the transition plan is evaluated as being successful. While Phase I proposals with the option will adhere to the 25 page limit (section 3.3), Phase II proposals together with the Phase II option will be limited to 40 pages. The transition plan should be in a separate document.

Evaluation of proposals to the Navy will be accomplished using scientific review criteria. Evaluation and selection of Phase I proposals will be based upon technical merit and other criteria as discussed in this solicitation document. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

TABLE 1. NAVY MISSION CRITICAL SCIENCE AND TECHNOLOGY AREAS

TECHNOLOGY	SCIENCE
Aerospace Propulsion and Power	Computer Sciences
Aerospace Vehicles	Mathematics
Chemical and Biological Defense	Cognitive and Neural Sciences
Command, Control, and Communications	Biology and Medicine
Computers	Terrestrial Sciences
Conventional Weapons	Atmospheric and Space Science
Electron Devices	Ocean Science
Electronic Warfare	Chemistry
Environmental Quality and Civil Engineering	Physics
Human-System Interfaces	Electronics
Manpower and Personnel	Materials
Materials and Structures	Mechanics
Medical	Environmental Science
Sensors	Manufacturing Science
Surface/Undersurface Vehicles	
Software	
Training Systems	

NAVY SBIR PROGRAM MANAGERS OR POINTS OF CONTACT FOR TOPICS

TOPIC NUMBERS	POINT OF CONTACT	PHONE
001-006	Mr. Douglas Harry	703-696-4286
007-016	Mr. Joseph Johnson	703-640-4801
017-019, 028, 032-033, 035-036, 052-053, 058	Ms. Cathy Nodgaard	703-604-2437 x6309
020-021	Mr. Curtis Snyder	301-826-7850 x103
022-025, 045-051	Ms. Carol Van Wyk	215-441-2375
026-027	Mr. Walt Kahl	301-826-7870
029-030	Mr. Peter (Pete) O'Donnell	908-323-7566
031, 037-044, 060-068	Mr. Eugene (Gene) Patno	805-989-9209
055-056	Ms. Janet Wisenford	407-380-8276
057	Ms. Patricia Schaefer	703-767-6263
034, 130-132	Mr. Donald Wilson	301-394-1279
054	Ms. Beth Klapach	301-743-4953
059	Mr. Jack Griffin	203-440-4116
069-129	Mr. William (Bill) White	703-602-3002
133-136	Lcdr Paul Knechtges	301-295-0885
137-138	Dr. Meryl Baker	619-553-7681
225-227	Mr. Nicholas (Nick) Olah	805-982-1089

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NAVY 96.1 TOPIC DESCRIPTIONS

OFFICE OF NAVAL RESEARCH

N96-001 TITLE: Technology for Affordability

OBJECTIVE: The objective of this project is to develop innovative process technology, concurrent engineering or manufacturing capable of effecting change in aircraft, ships, boats, or components thereof that will be cost effective, reliable, and maintainable.

DESCRIPTION: At the present time the manufacturing and engineering sectors of the country have been slow to transition new developments into production. Typically low volume implies high cost, and there is a dependence on low yield production of critical components. As a rule, activities above the factory floor drive costs, and there are high maintenance costs associated with new developments. Proposals are sought that will provide innovative developments in manufacturing and engineering systems; e.g., design for six sigma manufacturing, integrated product and process development, manufacturing processes/fabrication maturation, and advanced industrial practices (e.g., benchmarking and best practices--technical and business, etc.), that will effect the Navy and overall industrial production. A minimum of three Phase I awards will be made.

PHASE I: Identify improvements to be developed, and detail where and why they will be effective.

PHASE II: Choose one of those improvements, develop a working model/prototype, and demonstrate its performance characteristics. Develop a commercialization (Phase III) plan, including descriptions of specific tests, evaluations and implementations to be performed.

PHASE III: Implement the Phase III plan developed in Phase II.

COMMERCIAL POTENTIAL: Private sector applications and benefits must be inherent in the objective of the proposed effort.

N96-002 TITLE: Power Electronic Building Blocks (PEBB) Technology

OBJECTIVE: Develop enabling technologies for low cost, reliable, and easily manufactured, modular electrical power systems for current and future Navy applications.

DESCRIPTION: The Navy uses electric power in almost all platforms and systems. Advances in many systems areas are limited by affordability issues with the distribution, conversion and control of electrical power. Most current systems require the use of hybrid technology (i.e., electrical and hydraulic) and local manual controls which limit flexibility, and reliability. Advances in solid state electronic switching devices promise to make all-electric solutions feasible. This will not only make systems smaller, more capable and reliable but, with the application of sensor and communications technology, this will also create opportunities for distributed, remote and/or automated operation. However, if new power systems have to be designed for each new system, applications will be limited by affordability. Utilization of these advances will be cost prohibitive, unless the potential number of power electronics systems can be collapsed into a small family. Power conversion is the core of all power electronics issues, and most power circuit topologies are very similar. This fact can be used to enable a leap forward to some form of modular power building block. A broad range of scientific technological and engineering issues need to be addressed:

Flexible power circuit topologies
Semiconductor materials and devices
Internal signal processing and control technology
External control and communications technology
Flexible, reconfigurable electric power distribution bus and bus connections
Packaging emphasizing low cost manufacturing, cooling and EMI suppression

Affordability, maintainability, sustainability must be integrated with reliability into a standardized high performance modular power systems. These devices would be re-configurable & re-programmable to handle all types of electrical power tasks. They would be scaleable from the low kilowatt to high megawatt switching power ranges. They would be able to communicate status to the outside world and receive situational information and commands over some form of bus. They will have built in intelligence & sensing, to enable them to operate or shut down safely in emergencies or when disconnected from the primary

data bus/network. This SBIR will investigate and develop power electronics enabling technologies on a wide front to use them in the broader context of ONRs PEBB program.

PHASE I: Phase I will: (1) examine the issues relevant to the Navy, specifically and the power electronics industry in general; (2) investigate enabling technologies in the areas outlined above; (3) do feasibility studies; (4) develop conceptual and physical model and/or designs that accelerate the investigation of the above issues; (5) develop diagnostic and characterization technologies, tools and methods that monitor and address the above issues; and (6) identify a set of applications for the Phase II developmental model.

PHASE II: The second phase will (1) include detail designs; (2) develop appropriate prototypes and evaluate against simulations and models; (3) carry out an evaluation program and test against assumptions and models proposed in Phase I; (4) evaluate system applications for next generation units; and (5) identify manufacturing issues for large scale production.

PHASE III: Implement the technology in the PEBB program, and develop the manufacturing process to economically mass produce the units. Work with the PEBB to transition the technology to the various Navy power electronics initiatives.

COMMERCIAL POTENTIAL: The PEBB technology is intended to have a wide range of commercial applications. The technology can be used in building automation, factory automation, electric vehicles, and co-generation, to name a few.

REFERENCES:
1. H. Stevens, "Advanced Ship Machinery" Proc. National Power Electronics Workshop, NSWC, 16 Nov. 1994;
2. A.J. Tucker, "The More Electric Initiative and Power Electronics Building Block", Proc. National Power Electronics Workshop, NSWC, 16 Nov. 1994;
3. K. Shenai, R.S. Scott, and B.J. Baliga, "Optimum Semiconductors for High-Power Electronics", IEEE Trans, Electron Devices, vol. 36, no. 9, pp. 1811-1823, Sept. 1989;
4. "Proceedings of the Control Technology Workshop: The Regulation and Distribution of Power in Large Systems," Virginia Center for Innovative Technology, Herndon, VA, 24-25 April 1995.

N96-003 TITLE: AEW CMD Surveillance Modeling/Simulation

OBJECTIVE: Develop a high fidelity AEW (Airborne Early Warning) sensor model
incorporating space-time processing for enhanced detection of small, cruise missile (CM) sized targets.

DESCRIPTION: The addition of space-time adaptive processing to future Navy AEW radar systems could enable the detection of low RCS CM targets. This surveillance capability would provide for wide area search, and allow potential cuing to fire control assets. To exploit this technology, a high fidelity sensor simulation model is required, which can incorporate space-time transfer characteristics that have been developed off-line through other simulation and measurement programs. The sensor simulation model should be workstation based, run in real-time, and operate with physics based, deterministic background scenes and scenarios. Graphical displays should be provided allowing the user to observe radar outputs in PPI format, as well as control sensor parameters to enhance detection of small targets without an unacceptable high false alarm rate.

PHASE I: Develop the detailed architecture design for the workstation-based simulation, and demonstrate via a pilot program the rudiments of the proposed capability.

PHASE II: Develop the workstation-based simulation, incorporate the space-time transfer characteristics, and perform simulations of various tactical environments.

PHASE III: Produce the workstation demonstrated in the Phase II effort. Includes transition to other Navy programs such as Theater Air Defense (TAD), that will exploit high fidelity, physics based modeling.

COMMERCIAL POTENTIAL: The simulation modeling approach allows surveillance functions such as FAA air traffic control and local airport surface traffic monitoring to be interleaved; new sensor concepts can be accurately evaluated using realistic, deterministic background scenes.

REFERENCES: Cruise Missile Defense Advanced Concept Technology Demonstration (CMD ACTD) Phase I (Mountain Top) dated Aug 1994

N96-004 TITLE: Equations of State of Energetic Materials

OBJECTIVE: To develop E,P,V and T,P,V equations of state of unreacted explosive and propellants, for use in predicting

initiation and detonation phenomena in energetics and propulsion systems, where E,P,V, and T, are the specific internal energy, pressure, and specific volume, and temperature, respectively.

DESCRIPTION: The development of munitions and propulsion systems of high performance that are also invulnerable to accidental detonation is of major concern. The physical mechanisms of energetics/propellants initiation-to-detonation under various stimuli can be qualitatively explained by the complex phenomena of formation and reaction of "hot spots" formed in the energetic material. Inasmuch as the reaction of such hot spots is temperature dependent, any development of physical models for understanding the processes encountered require accurate E,P,V and T,P,V equations of state of unreacted energetics/propellants. Such equations of state, which are needed in codes that model warhead performance as well as initiation, explosion, and/or detonation of munitions and rocket motors by impacting fragments, blast waves, and slow and fast cook-off, have been studied far less than those of the energetic products.

PHASE I: Develop theoretical models of E,P,V and T,P,V equations of state of unreacted energetics (e.g., TNT, HMX, and RDX) that are applicable from the high-pressure (hundreds of kilobars) to the very low-pressure (1 bar) regimes and compare with available experimental data.

PHASE II: Continue improvements in the theoretical models developed in Phase I and apply them to more complex energetics and propellants. Develop alternative models, as necessary, for these more complex energetic materials. Compare the models for accuracy against available experimental data. Show how these equations of state influence the determination of the initiation characteristics and transition to detonation when employed with existing hot spot and other initiation models in computer code simulations.

PHASE III: The equation of state models developed in Phase II will be transitioned in safety and munitions development, as well as munition lethality and platform survivability, programs.

COMMERCIAL POTENTIAL: Knowledge of energetic transition-to-detonation under different stimuli has great implications on production, transportation, and storage of safe explosives used in the mining, excavation and demolition industries.

N96-005 TITLE: Shipboard Deployable Surface Target

OBJECTIVE: Demonstrate technology required for an affordable, self-contained, expendable, ship deployable target that is capable of being remotely operated at high speeds in rough seas.

DESCRIPTION: Navy surface combatant ships need a technology alternative to realistic training in support of gun firing. Current surface ship targets do not offer realistic training due to: (1) extreme sea state limitations; and (2) they cannot be hit or expended due to their high costs. In addition, current surface targets are environmental hazards and unsafe whenever hit or expended. Advanced simulation technology of surface threats, with use of remote controls and radar reflectors from personal type water crafts, offer a potential solution. This solution would provide a high speed target that can be ship deployed, and is expendable for the estimated cost of $15K.

PHASE I: Conceive and describe an affordable surface ship target that can be deployed by a surface combatant that offers realistic training in support it's gun firing. The conceived target must be affordable (less than $15K) and expendable. It must also be capable of remote operations in rough sea states and environmentally safe. The contractor will define the required technologies, hardware, software, and other target system requirements.

PHASE II: Develop, test and prototype the shipboard deployable surface target defined in Phase I. Define manufacturability and producibility of end product. Begin development of commercial market.

PHASE III: Deliver prototype shipboard deployable surface target to the fleet. Transition to commercial applications.

COMMERCIAL APPLICATION: The development of the conceived target system offers significant cost-savings to the commercial sector under current global and environmental conditions, and wherever realistic, expendable targets are required, such as, transportation safety.

REFERENCES: FY95 NSAP Task R-16-95, Shipboard Deployable Surface Target; COMNAVSURFLANT 082130Z May 95..

N96-006 TITLE: Intelligent Voice Recognition for Communications Priority Control

OBJECTIVE: Develop and test a methodology for an automated speech recognition system that can independently function as a centralized or decentralized component of the combat systems tactical information network.

DESCRIPTION: Recent technological advances in speech recognition systems provide credible speaker independent, connected speech processing. However, speech recognition systems do not perform additional processing based on the recognized speech or pattern. The proposal should address a hierarchical system that uses speaker independent connected speech using government furnished syntax from standard communication protocols. The system shall capture the utterances to synthesize, localize, classify, prioritize, alert, and catalog mission essential watchstation communications. Successful implementation of such a system will increase the confidence and reliability of the battle group for shared tactical communications. In summary, a speech recognition system is needed that is speaker independent (does not have to be trained or calibrated to the speaker's voice) which has the capability to process the verbal information, commands and syntax encountered in a tactical situation to accomplish information transfer (including automatic prioritization, classification, alerts, and mission cataloging) of watchstation communications.

PHASE I: Define a prototype speech recognition system. Define technical performance and reliability requirements the fault tolerant system modules must meet. Define the system tactical interfaces, data input/output requirements.

PHASE II: Develop, test and prototype tactical watchstation voice recognition system interface modules. Perform design verification and testing for manufacturability and producibility based on the requirements of Phase I. Begin development of commercial market.

PHASE III: Develop, test and integrate modules developed under Phase II into a combat systems tactical information network. Conduct system integration testing. Transition to commercial production. Deliver to fleet.

COMMERCIAL POTENTIAL: Software and related hardware developed will provide enhanced capabilities in situations using combinations of voice and digital inputs from multiple sources, such as: Hospital emergency rooms, 911 Operators and dispatchers, Air traffic controllers, Police/Fire dispatchers, Trucking agents, Merchant sea carriers, Voice mail operations.

MARINE CORPS

N96-007 TITLE: Composite Material Modeling for Blast Protection

OBJECTIVE: To develop a composite material model or existing model interface that will provide designs for vehicle blast deflectors and data on acceleration during mine encounters and secondarily the attenuation or defeat of fragment penetration/blast.

DESCRIPTION: The USMC has been developing crew/vehicle protection kits to provide increased crew survivability for tactical wheeled vehicles. Commonly encountered threats include on-route large blast mines with an additional threat of off-route fragmentation mines. While the USMC is achieving success against the threat levels of mines/fragmentation with conventional steel/aluminum protection kit fabrication, there are payload and mobility penalties associated with these protection kits. This research area is targeted at investigating ways to reduce these penalties while still providing the same level of crew/vehicle protection or improving the energy absorption performance of deflectors. Modeling and Simulation will provide a tool for paperless design and assessment of complex composite materials which show promise for reducing vehicle protection penalties while still meeting/exceeding survivability criteria. The composite material should mitigate 50% of mine energy, through absorption (material deformation) and blast deflection. Vehicle vertical and lateral acceleration should be minimized. The following are typical loading curves from a mine blast under a steel/aluminum protection kit:

Max Pressure Over Time	Max Stress Over Time
3000 ATM @ .074 millisec	67K PSI @ 5 millisec
1400 ATM @ .23 millisec	71K PSI @ 15 millisec
150 ATM @ .58 millisec	72K PSI @ 25 millisec
	60K PSI @ 30 millisec

PHASE I: Phase I will address the full matrix of tradeoffs for materials, performance, performance penalty, and manufacturability. The proposal must address, in detail, contemporary techniques for composite technology assessment. Existing blast models must be summarized with potential for integration. The Phase I proposal must contain at least an outline of the Phase II proposal direction.

PHASE II: Composite fabrication and evaluation will be conducted with designs generated by the model. Of primary importance is the blast/acceleration protection offered by the composite material as compared with vehicle weight penalty. The model will be assessed against existing Army field data for validation and performance. Phase II will also address properties to make the model user friendly. The model effort will be directed toward accuracy and also versatility in application, such

as the rapid, low cost application of modeling techniques to different vehicles and materials or configurations.

PHASE III: The final composite material model should be completed and validated. The commercial marketing plan submitted with Phase II should clearly specify additional uses for the model and simulation effort. It is desired that the product become available and have adequate documentation to facilitate DoD use.

COMMERCIAL POTENTIAL: Lightweight composites are finding many applications in the recreation industry. Security issues are increasing in the commercial sector which would provide ample opportunity for a lightweight ballistic material application. The aerospace industry is growing, with a high need for lightweight extremely resilient materials for satellite/space flight payloads. Ways of modeling these materials supports the commercial/DoD direction of paperless cost effective design.

REFERENCES:

1. "Army Material Command (AMC) Polymer Matrix Composites Assessment", August 1991
2. University of Delaware Center for Composite Materials, Annual 93-94 Report LH-92-80711-001
3. "Lightweight Hull Floor Program", General Dynamics Land Systems Division, Jan 1993 (produced for NSWC Carderock)
4. "Computer Programs for Structural Analysis", Engineered Materials Handbook, Composites, May 1933, ASM International Vol I.
5. "Computer-Aided Composite Design", Advanced Composite Magazine, March/April 1992
6. "Blast Simulation and Analysis", Science Applications Int. Corp., 30 May 94
7. "Development of Mine-Resistant Vehicles", SAIC, 2 July 93
8. "Blast and Structural Simulation/Analysis for Development of a Centerline Blast Deflector for the Cab of an M723A2, 5 Ton Cargo Truck", SAIC, 2 May 94

N96-008 TITLE: Corrosion Prevention and Control - Cold Application Hole Filler

OBJECTIVE: The objective of this topic is to identify a product to easily repair holes in sheet metal.

DESCRIPTION: Marine Corps tactical ground equipment is subjected to a harsh marine and operational environment. Wheeled vehicles, such as trucks and High Mobility Multi-Wheeled Vehicles (HMMWVs) get holes in the sheet metal due to corrosion, operational environment or artillery. A patching material with the same strength and flexibility as the surrounding metal that can be easily used is needed. The product should use a cold-application process and hand-tools. Currently new sheet metal is welded to the existing item. The repaired area must be worked until the repair is cosmetically acceptable. This process is very time consuming and requires extensive safety equipment.

PHASE I: Explore options to repair holes in sheet metal. Identify products that could utilize a cold-application process and no electric tools. Product must resist corrosion and accept primer and topcoat after repair is completed.

PHASE II: Using the results of Phase I, develop an easy to use product for maintenance personnel.

PHASE III: Implementation into existing maintenance procedures.

COMMERCIAL POTENTIAL: The auto repair industry would be able to use this process instead of welding new metal to the existing body part. The process should be safer and simpler than existing methods.

N96-009 TITLE: Entity Development Relative to Environmental Stimuli

OBJECTIVE: To develop a set of Marine Corps simulation objects that include features to interact with other simulation objects and respond to environmental stimuli.

DESCRIPTION: The end states articulated in the Marine Corps Modeling and Simulation Master Plan require authoritative representation of USMC simulation entities/objects germane to a synthetic littoral battlespace. Specifically, each of the eight end states requires modeling of Marine Corps units and equipment referred to as entities; and, the objects that populate the littoral environment (i.e. man-made and natural features in the littoral area). The entities must possess attributes that effectively represent the entity's behavior/performance in synthetic environments for analysis and training applications. Synthetic environments are constructed using models of physical environmental phenomena.

PHASE I: Investigate technology to enhance the current set of USMC simulation objects to respond to environmental stimuli. The proposal must address current techniques for representing environmental effects on simulated entities and the process by which the software is verified and validated. The Phase I proposal must contain the Phase II effort in at least outline

form.

PHASE II: Employ the enhanced objects in operational scenarios will be developed for training and analysis simulations. The modeling effort will be directed at high fidelity representation of physical environmental phenomena and the effect of the environment on operations. The inventory of Marine Corps objects should be completed.

PHASE III: The final product should be a complete and validated set of simulation objects that can be employed in a variety of scenarios.

COMMERCIAL POTENTIAL: The methods developed for integrating environmental phenomena with simulated entities for modeling large complex operations can be employed to enhance the utility of other simulations including: Fire Fighting, Law Enforcement, etc.

REFERENCES:
1. Marine Corps Modeling and Simulation Master Plan, 23 Jul 94

N96-010 TITLE: C2W Applications for Radio Frequency Weapons (RFW).

OBJECTIVE: The objective of this topic is to determine the application of RFWs in the C2W arena specifically communications countermeasures.

DESCRIPTION: Radio Frequency Weapons (RFW) are a family of weapons that includes High Powered Microwave (HPM) and Ultra-Wideband (UWB) devices. RFWs placed in close proximity to electronic equipment may have a greater effect on Command and Control (C2) equipment than conventional jamming without the unwanted side effects such as C2 fratricide or electromagnetic interference with friendly C2 systems.

PHASE I: Explore the application of HPM and UWB technology to satisfy the requirement to provide improved communications countermeasures to the Ground Combat Element (GCE) . At a minimum the devices should be able to generate sufficient power density to jam tactical radios in the HF through UHF frequency band. The ultimate goal is to provide a weapon capable of causing circuit disruption or damage.

PHASE II: Using the concepts developed in Phase I, demonstrate the ability of the RFW devices to interrupt C2 networks and equipment.

PHASE III: Integrate the identified technology into existing delivery devices within the T/E of the GCE and Combat Service Support.

COMMERCIAL POTENTIAL: Application of this research to commercial products would include security systems and law enforcement agencies. Applications ranging from communications to detection systems are envisioned.

REFERENCES:
1. Former Soviet Radio Frequency Weapons Programs; L. L. Altigilbers, J. D. Pryor, M. D. J. Brown
2. Investigation of Chaos, Fractal, and MultiFractal, Signal Behavior in Electronic Devices Exposed to High Power Microwaves; L. L. Altigilbers, J. D. Pryor, M. D. J. Brown

N96-011 TITLE: Emissions Reduction for Hybrid Electric Vehicles

OBJECTIVE: The objective is to reduce visible and NOX emissions of future hybrid electric vehicles.

DESCRIPTION: Hybrid electric vehicles are being developed for both commercial and military applications. The operation of the vehicles engine, which cycles on and off based on power need and electrical energy storage, greatly impacts the suitability of the platform to its commercial or military use. A very large percentage of noxious fumes and visible smoke generated by an internal combustion engine is produced during the starting and shutdown of the engine. Engine control strategies that work with the hybrid electric control strategies can address and minimize pollution and visible emissions through techniques such as high-speed engine starting, fuel retarding, and engine load management. The emission requirements will determine the on-off operation and the duty cycle of the engine which ultimately affects fuel usage and fuel efficiency.

PHASE I: Explore software and hardware based solutions to accurately and in real-time provide engine operation strategies for minimal emissions and pollution. An 80 kilowatt turbocharged, diesel engine driving a permanent magnet generator shall be used for baseline purposes. Electrical schematics, hardware concept drawings, and software and logic flowcharts shall

be delivered at completion of Phase I.

PHASE II: Using the chosen control strategies, a brassboard system with software loaded/embedded shall be developed and delivered, with interface information, for on-vehicle test purposes.

PHASE III: Ruggedize, miniaturize, implement and test in hybrid-electric vehicles.

COMMERCIAL POTENTIAL: The Clean-Air and Zero Emission vehicle mandates that take effect in 1998 are requiring electric and hybrid-electric vehicles in increasing numbers. Minimal pollution is the legislative prerogative, while minimal smoke emission is strongly desired even when it is not a pollution contributor.

REFERENCES: Peugeot XUD-11ATE engine technical description

N96-012 TITLE: Very Rapid Synthetic Urban Environment Generation for use in Virtual Reality Training Preview and Rehearsal Simulators

OBJECTIVE: To develop a mechanism for very rapid synthetic urban environment generation for use in virtual reality training, mission preview and rehearsal simulators.

DESCRIPTION: A small compact device is needed by infantry and reconnaissance small units or platforms. It must capture urban terrain and cultural feature information for processing for effective rendering in synthetic environment displays. The processing function will enable the feature representation to hold dynamic attributes appropriate to ground combat. The ultimate goal is to provide a patrol leader the ability to enter an urban sector, capture digitized information and images, conduct a real time down load and provide a dynamic database for virtual reality immersion

PHASE I: Explore the application of technology to satisfy the requirement to provide very rapid generation of synthetic urban environment databases. The Phase I proposal must contain the Phase II effort in at least outline form.

PHASE II: Using the concepts developed in Phase I, demonstrate the ability of the devices to capture, manipulate and display dynamic urban terrain databases.

PHASE III: Integrate the identified technology into existing systems within the T/E of the GCE and CSSE.

COMMERCIAL POTENTIAL: This technology would be useful to other emergency service organizations, law enforcement, urban planners, real estate developers.

REFERENCES: Marine Corps Modeling and Simulation Master Plan, 23 Jul 94

N96-013 TITLE: Expeditionary Containerized Warehousing Equipment

OBJECTIVE: To develop a lightweight mobility platform and intelligent manipulators to facilitate field deployable containerized warehousing.

DESCRIPTION: The USMC presently has no automated means of unstuffing combat service support containers delivered to forward areas of operation (AOA). Materials come to an AOA in a variety of packaging, primarily 8x8x20' containers and palletized loads. Containers are arranged in open storage areas, and contents are distributed as needed by a labor intensive and equipment intensive process. The USMC wants to expand expeditionary capabilities to include autonomous order filling from inventory stocks. Autonomous order filling is a multi-level problem. Asset identification systems exist within the DoD, and proposers can assume that the location of an item will be known. This information could be downloaded from a variety of deployed sources to an autonomous pick-and-pack system. Some technology areas to fulfill the mission include the routing of the load-collection vehicles, autonomous terrain navigation, selection of multiple items from multiple containers, handling of materials of differing sizes and shapes, and also for terrain mobility with the collected loads. Loads vary, but an example upper-end load is a pallet of ammunition weighing 2000 lbs.

PHASE I: Proposers should address all areas of the problem. The proposal may include some commercially available solutions for integration into the developmental system. Demonstration of knowledge of existing technologies will be weighted. The platform must have a level of mobility to traverse minimally prepared surfaces, including light vegetation, mud, and natural terrain contours. Proposers who demonstrate some core hardware success in Phase I will be weighted. The Phase I proposal must have at least an outline of the projected Phase II developmental cycle.

PHASE II: The proposer's core solution will continue into advanced development and prototyping. Commercially

available hardware solutions will be integrated into the proposer's developmental core solution, creating an overall increased USMC combat service support capability. Parameters of USMC operations, such as weight and cube of the proposed system will be addressed in detail in the Phase II solution, resulting from work with the USMC in Phase I. The end of Phase II will be a demonstration of this integrated technology, with interim demonstrations occurring at appropriate review points. Phase II must address in detail the corporate marketing plan.

PHASE III: Commercial venture with possible consideration for military acquisition. Phase III should guarantee a commercial availability of the developmental system for competitive solicitation and unit availability for independent testing by government installations.

COMMERCIAL POTENTIAL: Efficient warehousing has been the source of much success and investment for many commercial industries in the last 10 years. Autonomous warehousing is also a growing market. No effective way of doing outdoor warehousing with the same proficiency has emerged. Gardening and lumber industries are examples of outdoor based businesses which would benefit greatly from an affordable outdoor warehouse retrieval system.

N96-014 TITLE: Robo Fuel

OBJECTIVE: The objective is to develop an autonomous robotic refueler for dispensing fuel to fossil fuel burning vehicles. Removing the required human interface for refueling will reduce or eliminate some of the environmental impact associated with fuel transfer. Autonomous refueling will remove military personnel form potentially hazardous environments while increasing the efficiency of the refueling process.

DESCRIPTION: Robo fuel will consist of more than just a robotic arm with a fuel hose attached. Robo fuel will be a system which includes the robotic arm, but also incorporates modifications or adapters to the receipt vehicle fuel system. The major components of the system are:

- robotic arm 15 - 20' long, with fuel conduit and bayonet type nozzle on the end
- positioning beacon on the receipt vehicle which the robotic arm will sense and locate the refueling port
- information transfer connection so the robot can dispense the required amount of fuel
- adapter kit to incorporate double sealed (double sealed so outer seal prevents dirt and water from entering the system, the inner seal prevents fuel leakage from the tank) bayonet fitting on receipt vehicle
- information transfer connection which tells the robot the allowed flowrate for the receipt vehicle

The concept of operation is that a driver can pull into the station (or a mobile refueler can be brought along side) and be responsible only to get the vehicle refueling port within some allowable proximity of the robotic arm. At this point, the driver turns on the positioning beacon which wakes up the robot. The robotic arm will sense the position of the refueling port and automatically "stab" the bayonet nozzle into the port. The information contacts are made automatically at this point, and the receipt vehicle communicates to the robot the required amount of fuel and the allowable refueling rate (large trucks and heavy equipment for example can accept fuel at a much higher rate than automobiles). When the receipt vehicle is "full" the arm retracts into its neutral position awaiting the next vehicle. Robo fuel can be built as an attachment to existing refueling vehicles, built into a dedicated refueling vehicle, or as a stationary system. The fuel conduit in the robotic arm can be a fixed length, or variable length with the bayonet nozzle and hose removable in the event that the arm cannot reach the receipt vehicle's refueling port and manual refueling is required.

PHASE I: Select or develop a robotic arm of sufficient length,stiffness, and freedom of movement to support this concept. Select the position locator beam/beacon, bayonet nozzle and receipt fitting, and information transfer connection.

PHASE II: Fabricate prototype system which has the ability to locate the refueling port, identify required quantity and allowable flowrate.

PHASE III: Refine the prototype system based on the results of Phase II. Fabricate and deliver a pre-production prototype assembly for mounting on a Light Armored Vehicle (LAV). Deliver pre-production receipt adapter kits for installation on at least three different tactical vehicles (yet to be defined). Provide drawings for suggested modifications to future vehicle fuel systems to incorporate the robo fuel receiver concept.

COMMERCIAL POTENTIAL: With everybody wanting faster and easier services, this could be employed by the gas station industry. The customer could drive up, insert his/her bank card into a fixture located at the drivers window, then receive fuel without leaving the vehicle. The system will be environmentally friendly because the bayonet nozzle would allow true vapor recovery, and should eliminate spilled fuel. The system also has application to any commercial organization that operates a fleet of vehicles which are serviced at a central location. While the vehicle is receiving fuel, maintenance data (vehicle identification, odometer reading, etc) could be transferred to a central computer for improved maintenance scheduling. The military could

benefit from this system just as a commercial fleet. Additionally, the military can benefit from a refueler mounted system by enabling them to refuel in hazardous environments (tactical or NBC) as well as allowing them to refuel an entire convoy more rapidly regardless of the weather or light conditions.

N96-015 TITLE: Semi-active Suspension for Wheeled Vehicle

OBJECTIVE: The objective is to provide improved mobility for light vehicles in rough terrain environments.

DESCRIPTION: Future commercial and military vehicles (which may be based on commercial chassis' or components) will desire improved mobility. One unit of measure to determine improvement is reduced vibration transference to the driver. Current technology for suspension systems on light vehicles uses passive damping and spring systems which are harsh for small vehicles. Adaptive damping and springing without overly complex or expensive control systems (no terrain look-ahead), that can be fitted with existing spring or shock systems, offer mobility improvements at an affordable cost.

PHASE I: Explore and detail an actuation system mounted to a coil spring system for a four-wheel, 5000 pound vehicle that can adjust the spring and/or damping rate while the vehicle is on the move. Electrical schematics, hardware concept drawings, and software and logic flowcharts shall be delivered at completion of Phase I.

PHASE II: Using the chosen design for a suspension approach and technology, a vehicle set of components shall be developed and delivered, with interface information, for on-vehicle test purposes.

PHASE III: Ruggedize, implement and test in vehicles.

COMMERCIAL POTENTIAL: Sport vehicles, after-market modifications, and racing enthusiasts all desire improved speed-over-terrain while retaining vehicle control and sustaining minimal personal discomfort. Technology trends have shown that specialty components that improve performance generally make their way into production automobiles 5-7 years after introduction and demonstration.

N96-016 TITLE: Automated Flight Delivery System

OBJECTIVE: Enhance capability to precisely deliver logistic supplies (5,000 to 15,000 lbs or greater per vehicle) to remote locations, regardless of aircraft landing constraints.

DESCRIPTION: The automated flight delivery system: 1) should easily fold and store compactly, 2) is highly maneuverable with a high lift to drag ratio, 3) should deploy from flying aircraft, 4) should navigate autonomously to target, 5) will deliver varied cargo without damage, (6) should be able to land on all terrain with the cargo, and (7) should be able to be returned to a designed point by self-propulsion.

This flight delivery system should be inexpensive and capable of rapid attachment to the load. The delivery system should be completely self-contained, requiring no load modifications/special features other than fitting a weight/cube window. The delivery system should be able to be redeployed in a minimum amount of time from the forward austere environment.

PHASE I: Investigate application scenarios, develop a functional specification, develop system configuration criteria, identify guidance system costs/availability, evaluate concepts, and report on the results. Proposers reaching the hardware stage within Phase I will be given weighted consideration. The Phase I proposal must contain the Phase II effort in at least outline form.

PHASE II: Develop a proof of concept prototype, test and demonstrate the prototype, plan Phase III, and report.

PHASE III: Phase III will require military program sponsorship. For successful advance to this phase, a successful proof-of-concept must have been demonstrated, and the USMC sponsor for this SBIR effort will have coordinated transition to demonstration/validation. The contractor must support a successful Phase III transfer by maturing the product to a point for commercial consideration, including manufacturability and cost.

COMMERCIAL POTENTIAL: The private sector industry of supply service to remote locations can benefit from this technology. For example, the National Science Foundation conducts research in Antarctica with the private sector providing all logistic supplies during the summer months (no supplies are provided during the winter months). With an automated flight delivery system, the supplies may be delivered at almost any time by an aircraft that disgorges the system and cargo over the camp. The system would then glide to the landing zone safely and reliably. This system can also be used for delivery of emergency supplies to disaster relief or rescue efforts through out the world.

N96-017 TITLE: Improved Dynamic Derivative Development

OBJECTIVE: Develop a single technique/method for determining the most representative Dynamic Derivatives for aircraft throughout the entire flight envelope.

DESCRIPTION: Numerous sources are currently used to acquire predicted Dynamic Derivatives. These sources have included wind tunnel forced oscillation tests, rotary balance test, analysis and flight test data extraction. None of these sources has yielded Dynamic Derivatives that have been considered representative of the actual aircraft, nor have any of the predicted derivatives had any correlation with each other.

PHASE I: Determine primary and secondary sources for acquiring high fidelity Dynamic Derivatives that will accurately reflect actual aircraft characteristics. As part of this process, provide an assessment of all current capabilities for acquiring such data, and why each method is desirable or undesirable, with examples. Propose plan to validate results in Phase II. This plan should include use of simulation and/or flight test results to demonstrate the improved fidelity (enhanced flight safety) gained with the desired source(s).

PHASE II: Validate primary and secondary sources for acquiring/determining the Dynamic Derivatives. Produce software that can be used to rapidly develop the appropriate derivatives for each aircraft type from data derived from selected tests. Source code remains proprietary.

PHASE III: Produce software in a commercially and governmentally acceptable format that will enable the user to expeditiously determine dynamic derivatives recommended sources. (Effective 01 Oct 95, many of the critical facilities used by both sectors to gather this type data will be closed by NASA as part of downsizing. Some of these facilities will be privatized. As such, the product of this SBIR could be utilized by the vendor to support DOD/Commercial aircraft development from the private sector in a more profitable mode of operation.)

COMMERCIAL POTENTIAL: A single source for acquiring these derivatives will improve productivity and reduce costs for developing high fidelity simulations of aircraft. Improved dynamic derivatives will also aid design of aircraft and reduce potential re-design cost after aircraft is flown. Safety of flight will be improved by higher fidelity assessment capability of critical flight regimes. Privatized use of wind tunnel facilities will enable vendors to use this capability to support commercial and DOD developments.

N96-018 TITLE: Improved Wind Tunnel Test Technique

OBJECTIVE: Develop a test technique and identify the best facility that can be used as the primary source for high fidelity Dynamic Derivative development.

DESCRIPTION: A wind tunnel test technique (and associated facility to gather the data) is needed to obtain Dynamic Derivative data about all aircraft axes which would be more representative of actual aircraft motion, both linearly and non-linearly. Currently, many techniques and facilities are utilized, but frequently yield inconsistent data. In addition, none of these data accurately predict actual aircraft characteristics.

PHASE I: Determine the primary test facility/technique which should be utilized to gather Dynamic Derivative data about aircraft axes. This determination should also identify all current test procedures for all applicable test facilities. Assess limitations imposed in each of these facilities that contribute to problems associated with the acquisition of accurate data. Provide proposal to validate technique in Phase II, clearly demonstrating that the selected technique should be used as the primary data source. (This should include conducting tests, as needed, to verify test procedures. Incorporate data in representative simulation. Utilize flight test data, where applicable and available, to substantiate that improvements in test procedures has improved the quality of high angle of attack aerodynamic databases.)

PHASE II: Validate that the selected test facility/technique yields the highest fidelity Dynamic Derivative data. Identify software and hardware modifications that each facility can incorporate to improve this data acquisition. Develop software, as needed, for automated test procedures that can be utilized to improve the efficiency and accuracy of acquisition of the test data.

PHASE III: Produce the software and/or provide the hardware that can be utilized to improve the wind tunnel test and automated test techniques. Utilize techniques on developmental tests within the Government. Tailor procedures to meet specific needs of both commercial and Military organizations. Hardware/software could be used by company in privatized operation of existing wind tunnels.

COMMERCIAL POTENTIAL: Accurate wind tunnel test procedures are critical to development of both commercial and military aircraft. Software developed in conjunction with hardware improvements developed in this program are directly

applicable to commercial aircraft, since both the Military and Commercial sectors utilize the same wind tunnels to develop each product. Software and hardware can be packaged and sold to both Government and Commercial sectors. Source code remains proprietary to developer. In addition, a majority of wind tunnels utilized by the Government and Industry are NASA facilities. (Effective 01 Oct 95, many of the critical facilities used to gather such data by both Government and Industry will be closed by NASA as part of downsizing. Some of these facilities will be privatized. As such, the technique/facility identified in this SBIR could be utilized by the vendor to support DOD/Commercial aircraft development from the private sector in a more profitable mode of operation.)

N96-019 TITLE: Improved Wind Tunnel Data Reduction Procedure

OBJECTIVE: Develop a universally accepted data reduction procedure for data acquired in dynamic wind tunnel testing. These tests include rotary balance, forced oscillation and plunging type techniques.

DESCRIPTION: Develop methodology and software tools that can be utilized to reduce data and provide the aerodynamic coefficients as a non-linear function of aircraft rotational rate and dynamic data as a function of aircraft angular rates. Currently, data is not provided to the DOD or Industry in a format compatible with flight simulations, and as such, has not been used properly to predict aircraft motions.

PHASE I: Determine the optimum method/procedure for reducing dynamic wind tunnel test data into a format that can be used readily by DOD and Industry. As part of this development, identify aerodynamic coefficients requiring improvement and that contribute significantly to high angle of attack databases. Document how these procedures differ from existing techniques and how they will improve the quality of data reduction. Identify tests that can be accomplished in Phase II that can be used to demonstrate how these procedures will be validated. (This should include a proposal to demonstrate how these procedures can be universally applied to all aircraft types from various test facilities. Verify that the data produced from these procedures more accurately replicates actual aircraft characteristics by correlation with flight test results (as available).

PHASE II: Validate that the data reduction procedures developed in Phase I provide the highest fidelity data from each wind tunnel test. Develop the software that will enable DOD/Industry to reduce this data readily. Conduct tests as necessary and/or utilize existing data to verify new procedures to produce improved simulations and prediction techniques. Provide details on how the software developed to support this data reduction is unique such that one unified procedure for data reduction can be used by commercial and Government users.

PHASE III: Provide data reduction method and software developed in Phase II in a commercially and Governmentally acceptable format. Incorporate data reduction procedures in developmental tests. Tailor procedures to meet the needs of both commercial and Military organizations. Source code remains proprietary to vendor.

COMMERCIAL POTENTIAL: Improved wind tunnel data reduction procedures are directly applicable to the design of both commercial and Military aircraft, since the same wind tunnels are utilized for both developments. A universally accepted procedure will improve productivity and efficiency in wind tunnel testing. (Effective 01 Oct 95, many of the critical facilities used by both parties will be closed by NASA as part of downsizing. Some of these facilities will be privatized. As such, the product of this SBIR could be utilized by the vendor to support DOD/Commercial aircraft development from the private sector in a more profitable mode of operation. Since the product should be one that can be used by commercial and Government sectors, the vendor has a significant market available to sell their product.

N96-020 TITLE: Innovative Lightweight Recuperative Gas Turbine Turboshaft Engine Development

OBJECTIVE: To develop an Innovative, Lightweight Recuperative Gas Turbine Engine System For use in Unmanned Aerial Vehicles

DESCRIPTION: Current recuperators used on gas turbine engines operate with a thermal efficiency near 80% but incur a weight penalty due to their being constructed of stainless steel. The heavy weight of the recuperator negates any increase in brake specific fuel consumption (BSFC) gained by its use. An innovative and lightweight recuperator system must be conceived in order for the UAV community to benefit from the decreased BSFC generated by the recuperative technology. Specifically, a turboshaft system that meets the following specifications is required:

Maximum power range from 60 to 120 shaft horsepower
Recuperator thermal efficiency greater than 90%
System power to weight ratio not less than 1:1

BSFC not greater than 0.5 lb/hp-hr over entire operating range

PHASE I: Conceptual designs shall be generated and validated through bench testing or with a pre-production prototype design. A weight reduction plan (if required) must also be generated for Phase II implementation.

PHASE II: Fabrication and test of pre-production system that meets all system requirements described above to verify system performance.

PHASE III: The technology developed will be transitioned to commercial manufacturers for applications involving small turboshaft engine in which fuel savings are important.

COMMERCIAL POTENTIAL: This technology can be used by the private sector to replace conventional turboshaft engines in order to lower operating costs by drastically reducing fuel consumption costs. Applications include UAVs, generator sets, fire pumps.

REFERENCES: Unmanned Aerial Vehicles Master Plan 1994

N96-021 TITLE: Innovative Small, Heavy Fuel Engine Concepts

OBJECTIVE: To examine breakthrough, state of the art, innovative small heavy fuel engine concepts to determine feasibility of concept

DESCRIPTION: The Navy desires to consider advanced innovative small internal combustion engine concepts that will advance the present sate of the air (power to weight) in the 25-100 horsepower range with applications including unmanned aerial vehicle, generator sets and portable fire pumps. Innovative concepts shall focus on both JP-6 and JP-8 fuel (heavy fuel) operation and lightweight construction. Engine concepts shall have power to weight ratios approaching 1.0 and brake specific fuel consumption not exceeding 0.7 lbs/hp-hr.

PHASE I: Conceptual designs shall be generated and validated through theory, analysis and subscale testing.

PHASE II: Fabrication of full scale designs and experimental verification of the concept.

PHASE III: Produce limited numbers of pre-production engines for field demonstrations and validation.

COMMERCIAL POTENTIAL: Numerous uses of small gasoline engines would be replaced by equivalent performing diesel fuel engines that are inherently safer.

N96-022 TITLE: Reinforcement Learning For Flight Control

OBJECTIVE: To develop and demonstrate the use of reinforcement learning for flight control optimization in either the design process or through on-line learning.

DESCRIPTION: To date, most of the research that has been done in applying learning to flight control has used some form of supervised learning. However, recent advances in reinforcement learning have demonstrated it to have strong potential for improving control systems through design optimization or on-line learning. For flight control, reinforcement learning may be used to optimize either inner loop tasks such as primary command and stability augmentation or outer loop tasks such as automated trajectory control for weapons delivery or terrain following/terrain avoidance. If it is an inner loop controller it must provide acceptable pilot handling qualities. In all cases, it must be sensitive to real-world implementation issues such as validation and computational overhead.

PHASE I: The proposed reinforcement learning algorithm shall be demonstrated on a flight control element of a simplified high performance aircraft model.

PHASE II: The reinforcement learning technique shall be demonstrated on a medium or high fidelity nonlinear aircraft model with sufficient complexity for a proof of concept. This aircraft should exhibit both static and dynamic instabilities, disturbances, sensor noise, and uncertainties in its plant dynamics.

PHASE III: Phase III will develop a software package for use by government and industry to apply the proposed reinforcement learning algorithm to a wide range of control systems.

COMMERCIAL POTENTIAL: There is currently a strong demand for learning controllers in a variety of areas including aircraft, robotics, and computer-integrated manufacturing. As a result, the methodology and software package should have

strong commercial potential, if successful.

REFERENCES:
1. M. Steinberg, "An Initial Assessment of Neural Networks & Fuzzy Logic for Flight Control," *Proceedings of the 1994 American Control Conference*, 1994.
2. D. White, D. Sofge (ed.) *Handbook of Intelligent Control: Neural, Fuzzy, and Adaptive Approaches*, Van Nostrand Reinhold, New York, 1992.

N96-023 TITLE: Optimized Ejection Seat Control Theory and Microprocessor Controller

OBJECTIVE: The development of both an ejection seat controller and an analysis tool which will model free stream dynamics of the ejection seat with the implementation of feedback control of propulsion and aerodynamic control surfaces.

DESCRIPTION: A microprocessor controller and control law shall be developed to interface with the aircraft and provide feedback control of ejection seat propulsion and aerodynamic devices as well as event sequences such as parachute deployment. By modeling the seat aerodynamics, aircraft proximity effects, and mass properties, optimized control gains shall be developed utilizing a linear quadratic regulator (LQR) or other suitable approach. Feedback control is anticipated to incorporate attitude and heading, and to maintain acceleration levels within human tolerance when possible.
The final configuration of the seat controller shall be approximately 100 cubic inches and mounted on the seat. It shall be exposed to harsh environmental conditions and it must operate under high acceleration and vibration conditions. The unit shall contain all software and hardware necessary to interface with the aircraft and provide ejection seat control.. The control algorithm shall be applied to the controller hardware specifically developed for escape system propulsion actuation and event sequencing. The control theory shall also be used as an escape systems analysis tool. For Phase I, the configuration of the control theory analysis tool shall operate on a stand alone computer workstation (UNIX or PC).

PHASE I: The effort for Phase I shall concentrate on developing the basic tools and models, including the implementation of the seat system aerodynamics and mass properties. The offeror shall evaluate various analysis tools (software) or develop analysis methods specifically for the use with escape systems, both ejection seats and capsules. It is expected that a usable analysis software and data shall be delivered at the end of this phase. For Phase I, the offeror shall also identify the basic micro-computer architecture which shall meet the computational and speed requirements for control of an ejection seat.

PHASE II: If Phase I is successful, the offeror shall fully develop the analysis tools so that any change in configuration (aerodynamics or mass properties) could immediately be evaluated, and a new gain schedule developed. Initial implementation of the control theory shall also be investigated through the trade study of available microprocessor hardware. The software and hardware systems shall demonstrate real time operation. Deliverables at the end of Phase II shall include the final analysis software with manuals, as well as a developmental microprocessor system with operational control algorithms.

PHASE III: If Phase II is successful, it is anticipated that a Phase III effort will be funded to fabricate the controller hardware and software which shall be adaptable to developmental escape systems.

COMMERCIAL POTENTIAL: This topic and the technology spin-offs could offer commercial potential in the area of control theory design and air vehicle auto pilots.

REFERENCES: MIL-S-18471G

N96-024 TITLE: Adaptive Lumbar Support/Alignment System

OBJECTIVE: The objective of this topic is to develop an adaptive lumbar support/alignment system to optimize the vertical alignment of the lower spinal column during aircraft ejections and helicopter crashes.

DESCRIPTION: During the early stages of an ejection, an aviator can be exposed to injurious levels of acceleration induced loads along his or her spinal column. Consequently, fractures of the lower thoracic and upper lumbar vertebrae have been documented as one of the most dominant major injuries which occur prior to ejectee egress from the aircraft. Similar statistics have been observed during helicopter mishaps. Among the numerous injury-related factors, which include weight, height, age preexisting conditions, etc., researchers have consistently identified poor posture (i.e., poor alignment of the spinal column prior to ejection) as a major causal factor in G_z- related injuries to the lower spinal column. Analytical and empirical investigations have demonstrated that the proper alignment of the lower spinal column can significantly reduce the potential for injury. Recent

technological advances may enable the development of a small, light-weight device which can be used to adaptively reorient the aviator's lower spinal column prior to ejection or helicopter impact. Easy retrofit of the device into existing ejection hardware and crashworthy seating is desirable. Proposers should include a preliminary design of an adaptive lumbar support/alignment system as part of their proposals.

PHASE I: At the end of the six month effort, Phase I should result in a detailed conceptual design, analysis, and proof of concept.

PHASE II: Develop and deliver a fully functional prototype lumbar support/alignment system that fulfills the Phase I objectives.

PHASE III: Refine the prototype hardware and deliver pre-production units.

COMMERCIAL POTENTIAL: This item has commercial applications in the automotive industry.

N96-025 TITLE: Lightweight Composite Sandwich Structure for Navy Aircraft

OBJECTIVE: Develop lightweight composite sandwich structures, fabricated of woven preform and resin transfer molding (RTM), that retain no moisture and eliminate corrosion with improved damage tolerance.

DESCRIPTION: The benefits of weight, cost, and supportability savings for high performance air vehicles can be realized if the structural components are designed and fabricated with improved structural integrity. Sandwich structures utilizing honeycomb cores are considered most weight efficient. But retention of moisture with honeycomb core degrades the structural integrity leading to premature failure of the component. Development of composite sandwich structures fabricated of appropriately woven preform and resin transfer molding or similar process could provide cost effective sandwich structural components that retain no moisture, eliminate corrosion, and improve damage tolerance. The woven preform should be such that it will allow passageways for moisture drainage in the sandwich. The sandwich structures should contain no moisture-retaining material in the core, such as foams or similar materials. The entire sandwich should cured in single cure operation without any secondary operation such as bonding. The materials for fabrication should have nominal properties similar to fibers AS4 or IM6 and resin 3501-6 or 977-3. The basic strength parameters, such as effective transverse shear, flexural, and twisting stiffnesses should be comparable to that of honeycomb sandwich. Practical consideration should also be given to the supportability of the sandwich structures. The developed sandwich structures will be applicable to both DoD and commercial aircraft.

PHASE I: Develop woven preforms and methods for resin transfer molding or similar processes to fabricate specimens and perform preliminary analysis and tests for stiffnesses and strengths applicable to Navy aircraft environment.

PHASE II: Improve the weaving pattern and fabrication technique and perform analysis and comprehensive tests for stiffnesses, strengths, and damage tolerance. Develop appropriate repair methods for supportability.

PHASE III. Develop and fabricate representative components and subcomponents for Navy and commercial aircraft. Perform analysis and tests for strength and damage tolerance

COMMERCIAL POTENTIAL: Presently honeycomb sandwich structures are used in commercial aircraft. Development of proposed sandwich structures will improve structural integrity considerably, and reduce substantially the repair costs related to corrosion, impact damage and debonding.

REFERENCES:
(1) H. Ray, "Investigation of Advanced Lightweight Sandwich Structural Concepts," Report NAWCADWAR-93064-60, NAWC-AD, 1993.
(2) C. Libove and R. E. Hubka, "Elastic Constants for Corrugated-Core Sandwich Plates," NACA, TN2289, Feb 1951.
(3) H. G. Allen, Analysis and Design of Structural Sandwich Panels, Pergamon Press, 1969.

N96-026 TITLE: Aircraft High Alpha Dynamic Analysis

OBJECTIVE: Develop system identification algorithms and software for complete nonlinear analysis of aircraft high angle of attack dynamics.

DESCRIPTION: High angle-of-attack control and maneuverability are important concepts for combat effectiveness of the new class of fighters such as F-18, F-22 and JAST. A thorough understanding of aircraft departure characteristics and super

maneuverability requires analysis of large amplitude aircraft motions at high angles-of-attack. At present, there is a lack of analytical methods for investigating the stability and control properties of aircraft during such highly nonlinear maneuvers. The objective of proposed Phase I and II research is to develop algorithms and software for complete nonlinear analysis of high alpha dynamics. These techniques will predict dynamic phenomena such as wing rock, tumbling, post-stall gyrations, limit cycles, chaotic motions and other types of bifurcations, using high alpha aerodynamic and propulsion data. In addition, their application to Pilot Induced Oscillations (PIOÕs) and controller designs to improve high alpha characteristics will also be investigated

PHASE I: Provide a feasibility study which develops the theory and algorithms required for the identification of the non-linear high angle of attack aerodynamic characteristics.

PHASE II: Develop, test and operationally demonstrate the identification methods formulated under the Phase I SBIR effort.

PHASE III: Produce the non-linear system identification methods demonstrated in the Phase II effort. This will be the transition from development to application for major aircraft programs such as the F-18 E/F and V-22.

COMMERCIAL POTENTIAL: Successful development of software will help fighter aircraft designers and engineers in rapidly analyzing various aircraft designs and anticipating stability problems prior to flight test. In addition this effort will also improve the ability of aircraft training systems provide high fidelity training in high angle of attack flight. This is expected to save millions of dollars in the design of fighter aircraft and the development of flight control systems. The nonlinear analysis techniques will also apply to other systems which exhibit bifurcations, stall and chaotic motions. Such systems include helicopters, turbine engines, electric power systems, submarines and a large class of vibration problems in nonlinear mechanical systems.

REFERENCES: MIL-STD-8785C

96-027 TITLE: Innovative Lightweight Unmanned Air Vehicle (UAV) Fuel Injection System

OBJECTIVE: To Develop a Lightweight Fuel Injection System for Use in UAV Heavy Fuel Engines.

DESCRIPTION: Fuel injection systems currently designed for automotive and diesel applications are too heavy for use on UAVs, where any additional weight is a penalty. Specifically, a system that meets the following specifications is required:

Operation on JP-5 and JP-8 fuels without lubrication additives
Engine operating speed range from 500 to 7000 RPM
Maximum output power range of 20 to 100 HP
Injected Fuel Volume Turndown Ratio of 10:1 (idle to max)
Adjustable injection timing
Adjustable injection duration
Fuel infection pump operational life greater than 500 hours
Minimum fuel injection pressure of 5000 psi
Constant fuel injection pressure (no variation with speed)
Total system weight (injection pump, injectors, injection lines, fuel filters and fuel pumps) not to exceed 10 pounds

PHASE I: Conceptual designs shall be generated and validated through bench testing or with a pre-production prototype design. A weight reduction plan (if required) must also be generated for Phase II implementation.

PHASE II: Fabrication and test of pre-production system that meets all system requirements described above to verify system performance.

PHASE III: Transition technology to commercial manufacturers for applications involving small engines (less than 100 horsepower).

COMMERCIAL POTENTIAL: This technology can be used by the private sector to replace gasoline engines with lower cost heavy fuel engines in areas such as generator sets, motorcycles, pumps welding machines, etc..

N96-028 TITLE: THERMAL INVESTIGATION OF ARRESTING HOOKS

OBJECTIVE: Develop capability to analyze the variables contributing to the cracking of the arresting hooks and improve the manufacturing processes

DESCRIPTION: Utilizing modeling techniques, analyze the material and thermal variables contributing to cracking of arresting hooks during hard face coating, fusing and heat treatment, and improve the manufacturing processes to eliminate cracking.

PHASE I: Develop an analytical model to evaluate the material and thermal variables that impact the manufacturing of the arresting hooks. Analyze the material and thermal properties contributing to cracking of arresting hooks during hard face coating, fusing and heat treatment through computer modeling utilizing finite element analysis to account for the difference in the geometry and mass of the hooks, heating rate, coefficient of thermal expansion and contraction and other applicable material and thermal properties. Coating variables have to be incorporated. Temperature distributions have to be established. The analytical results will be validated against the experimentally tested results.

PHASE II: Refine/Improve hard face coating and heat treatment processes and validate against the analytical results. Prove the process doable in a production environment. Develop statistical process control requirements. Develop non-destructive inspection techniques to examine the base metal through various coating thicknesses and establish the base metal structural integrity..

PHASE III: Validate the processes developed including the statistical process controls for all the currently procured hooks.

COMMERCIAL POTENTIAL: The approach in the development of computer modeling and the resulting optimized processes to produce hooks under statistically significant process controls should find excellent other military, commercial and industrial applications.

N96-029 TITLE: Low Energy Aircraft Launch Assist Device

OBJECTIVE: To develop an advanced launch assist device for both the Navy sea based and Marine Corps land based current and future Conventional Take-Off and Landing (CTOL) aircraft, Vertical Short Take-Off and Landing (VSTOL), and Advanced Short Take-Off and Vertical Landing (ASTOVL) aircraft.

DESCRIPTION: For the last 70 years, the Navy has used some type of catapult to help propel carrier based CTOL aircraft to their required launch speed within the confines of the flight deck.. The first catapult was a cable type driven by a flywheel. Follow-on types included pneumatic, explosive and hydraulic. These were all indirect drive mechanisms. Today's aircraft carriers employ direct drive steam powered catapults. These systems were developed in the 1950's, are heavy, large, inefficient, manpower intensive, are completely dependent on the ship's propulsion system, reduce the structural life of all seabased airframes and are at the limit of their performance capabilities. The Navy desires that it's future seabased tactical aviation platforms be physically smaller and more efficient in terms of space utilization, machinery and operations. For aircraft launch and recovery operations this means making more efficient use of the flight deck real estate (i.e. reducing the area required for launch and recovery) and in reducing the impact to ship operations (i.e. reducing the required wind over deck). US Navy efforts conducted in the 1970's, along with operational experience gained by other Navies, demonstrated the tremendous benefits provided by utilizing Ski-Jump technology in the launch of VSTOL aircraft. Benefits in terms of reduced take-off distance, increased payload capability and reduced stress imparted to the airframe have been demonstrated. Studies have also shown that similar benefits are to be gained for CTOL aircraft by incorporating a launch assist device into the ski-jump. In addition to supplying kinetic energy to the aircraft, the launch assist device would also serve to act as a guide for STOVL aircraft allowing takeoffs in out-of-wind/ship motion conditions and provide aircraft directional control when approaching minimum single engine control speeds. This type of configuration would also be extremely beneficial for Marine Corps CTOL and VSTOL aircraft launch operations from Expeditionary Airfields.

A low energy aircraft launch assist device is needed to permit the launching of CTOL, VSTOL and STOVL aircraft from future seabased tactical aviation platforms and landbased Expeditionary Airfields. This device must fully integrate with a ski jump. To minimize the ship impact, in terms of lost deck spots, and to optimize the launch angle for different aircraft, the ski jump will be a curvilinear ramp fully adjustable from 0 degrees through 8 degrees. The launch device must function within this constraint. The length of the launch assist device must be contained within the total length of the ski jump which will not exceed 200 ft. The device must operate with closed loop feedback control. The energy output of the device must be adjustable from 5 to 60 million ft lbs. The device must be compatible with the current method of coupling to the aircraft. Due to extensive experience with indirect drive systems, direct drive is preferred. The prime power for this device must be compatible with sources available aboard ship and at an Expeditionary Airfield.

PHASE I: During Phase I, the contractor shall determine the optimum launch assist device for launching aircraft in combination with a ski jump based on a technology trade-off study. The contractor shall then proceed with a conceptual design of the launch assist device.

PHASE II: The contractor shall provide a detailed design of the launch assist device. The contractor shall also provide

a working scale hardware model of the device. The model should be based on a 1/4 energy scale. The contractor shall use the model to demonstrate the required scaled and adjustable energy output and how it would integrate and operate with an adjustable ski jump.

PHASE III: A transition to an advanced development program by the contractor will provide a full scale launch assist device, capable of being integrated into a full scale ski jump and launching representative aircraft.

COMMERCIAL POTENTIAL: This technology can be applied to automotive crash testing or any other application which requires the rapid acceleration of large bodies.

REFERENCES: NAVAIR 51-15ABD-1, Technical Manual, Operation Instructions, Catapult Type C Mark 13 Mod 1 for CVN68 through CVN71, and Type C Mark 13 Mod 2 for CVN72 and CVN73.

N96-030 TITLE: Electric Power Transfer

OBJECTIVE: To develop an advanced concept for use in linear motors which would permit the transferring of electrical power from a stationary source to a moving member and that is inherently reliable, safe, and electromagnetically compatible.

DESCRIPTION: The purpose is to develop an advanced electrical power transfer concept that can be utilized to implement advanced electrical systems on aircraft carriers. The present technology of transferring electric power does not allow for an efficient, safe, and reliable method of transferring power. This becomes evident when observing that brushes are one of the highest maintenance items for electric motors and generators, even in a protected environment. The electric power transfer concept to be developed shall have the capability of providing electrical power from a stationary source to a moving platform in an inherently efficient, safe, reliable, and electromagnetically and electrically compatible manner. (An analogous geometry would be an electric locomotive, with a power bus alongside the track and brushes attached to the locomotive, providing the power transfer). The projected length of travel would range from 5 feet to approximately 500 feet and is environmentally exposed, velocity of the moving platform would range from 0 m/s to 100 m/s. The characteristics of the electrical power include ranges from DC to 400 Hz, up to 5 KV, up to 1 MW, 3 phase.

PHASE I: The contractor shall determine, through analysis, the optimum concept for transferring electrical power, given the constraints. The contractor shall identify the technologies involved and the approach to overcome the risks associated with implementing the proposed concept and technologies. The contractor shall provide a preliminary design of the concept.

PHASE II: The contractor shall develop working scale models which demonstrate the feasibility of the proposed technologies. The contractor shall provide a detailed design of the proposed concept.

PHASE III: A transition to an advanced development effort by the contractor will provide a full scale electric power transfer system, capable of meeting the aforementioned requirements.

COMMERCIAL POTENTIAL: An advanced electrical power transfer concept has wide applications in electric motor and generator technology. An advanced electric power transfer concept would have a significant impact on efficiency and maintainability, which could have dramatic effects on the overall electrical industry. Direct applications include materials handling, elevators, and mass transit systems. Another advanced technology application includes magnetic levitation (MAGLEV).

N96-031 TITLE: Magnetic Resonance Imaging for Materials Applications

OBJECTIVE: Develop methods and assess present day technology for the use of Magnetic Resonance Imaging (MRI) in the characterization of baseline and aged rubber and composite materials.

DESCRIPTION: Composite materials and cured rubber formulations are used increasingly for Navy and DoD applications. The characterization of defects and study of aging in these materials generally involves some form of destructive analysis. Many of the currently used methods do not provide the necessary data required to determine shelf life, detect material stress features, or determine the detrimental effects of, for example, water or jet fuel absorption. MRI has been used to study composite and rubber materials and the results to date have been used to identify mechanism of solvent ingress, to map stress regions, to determine cure state, and to non- destructively identify material defects. This effort will allow us to assess the technology for transition to Navy and DoD materials issues and to get a head start on materials characterization for future platforms and weapons programs.

PHASE I: Provide a feasibility study which develops methods for studying small scale (20 mm) samples of composite case and liner materials. Samples with known defects, solvent ingress, or damage will be compared to baseline materials and, in addition, state of cure of composites, liners, and rubber formulations will be assessed. We will also provide specific samples containing weld lines or bond lines and samples displaying heat damage. The methods proposed to evaluate samples will be tested and a report will describe the success or failure of these test methods.

PHASE II: Transition test methods described above to large scale materials like composite case weapons or aircraft structural parts.

PHASE III: Implement test methods at a Warfare Center or Depot.

COMMERCIAL POTENTIAL: MRI was transitioned from a laboratory curiosity to the medical diagnostic field over the past 15 years. Developments in materials diagnostics are now at the laboratory curiosity stage and the transitions to industries such as the tire and rubber industry and the food processing industry, as well as a host of others, are moving forward.

N96-032 TITLE: Light Weight High Voltage Power System

OBJECTIVE: Replace the current High Voltage Power Supply System with one of the same KVA rating but with fewer or lighter power modules for weight reduction and improved reliability.

DESCRIPTION: The Navy currently uses a high voltage power supply consisting of eight, 90 lb, 30 KVA, 270VDC power supply modules to support a strategic communications aircraft. These modules convert aircraft AC input power to DC power that is applied to Radio Frequency (RF) Power Amplifier Modules (PAMs). Subsequently, the PAM uses the 270VDC power to amplify an RF drive signal from another source. The 270VDC PAM incorporates both soft start and soft stop capability to minimize damaging stress which reduces reliability of aircraft AC power sources. Given the obvious advantages in decreasing the weight of avionics systems, reducing the weight of aircraft power amplifiers offers a cost effective means of achieving that goal. This effort will increase the voltage per pound of power amplifier for all power amplifier users.

PHASE I: Provide a feasibility study which analyzes existing rectifier/filter, multipulse power supply topology for weight reduction possibilities. Additionally, alternate high voltage power supply switcher topologies should be considered.

PHASE II: Develop, test and operationally demonstrate the high voltage power supply requirements under the Phase I SBIR effort.

PHASE III: Produce the demonstrated high voltage power supply in the Phase II effort.

COMMERCIAL POTENTIAL: New lighter weight power supplies can be used with other avionic applications.

REFERENCES: Rockwell Document No. HPTS-1002-1, dated 09 April 1993

N96-033 TITLE: Massively Parallel Processing for Image Processing

OBJECTIVE: To develop a high quality imaging capability for use in developing real-time military and commercial imaging applications. The system utilizes a 64K Massively Parallel Processing (MPP) board, together with Operating System (OS) software installed on a HP-748 workstation. The system provides the workstation with the capability of generating real-time high fidelity, high pixel density and high refresh rate graphic images.

DESCRIPTION: A critical situation has developed across a broad range of service programs involving the time it takes to produce high quality graphic images for use in real-time military applications. To solve this problem, a 64K MPP board together with OS software will be developed and installed on a HP-748 workstation. Achieving this goal provides the following benefits: (1) the removal of the speed bottleneck involving image processing by producing high fidelity, high pixel density and refresh rate images in real-time, (2) provide the developer with a dual use accelerator board for use in developing vertical military and civilian applications and (3) provide the developer a platform for developing 256K and 1024K MPP boards aimed a achieving the goal of one processor per pixel. The development effort needed to achieve these goals involves the following:

PHASE I: Requirement definition development from liaison with workstation manufacturer and software algorithms producers. Analysis of specific software with respect to the underlying native parallelism in the mathematical algorithms. Applications developed linking the MPP board OS and libraries to the host processor OS and application software. MPP chip development and procurement. MPP chips are ready for use. Module specification will be given for multichip modules of 4K chips in a ASIC design. After fabrication and testing the ASIC chips will be incorporated in the 64K processor board.

PHASE II: The MPP board specification will be finalized, followed by the design layout phase, fabrication, assembly and testing. The MPP board baseline will have 64K processors implemented with 16x4K processor multichip modules each incorporating 16x256 processor VSLI MPP chips. The specification, design, implementation and testing of integrated MPP-host system OS and programming tools. Installation of MPP64K processor board, OS, libraries and application specific software installed on a HP-748 workstation. The prototype system will be performance tested and demonstrated using application specific software.

PHASE III: Product developed through this SBIR initiative can be used by aviation system program managers in the Navy, Air Force, and Army, as well as the commercial sector to implement new training technologies and to enhance systems currently in use. The system has direct application to telemedicine since high speed imaging is required for practical implementation of medical imaging system.

DUAL USE COMMERCIALIZATION: Use of the MPP board, OS and support software in developing military and commercial applications such as accelerator hardware platforms for multiple software products, realistic aviation-related simulators, biomedical imaging and telemedicine applications and real-time virtual reality training environments.

N96-034 TITLE: Smart Search Planning Algorithm

OBJECTIVE: A methodology is sought for performing an optimal search, over a pre-defined irregular geographical area, for a hunter/seeker missile, attack aircraft, or UAV to find an imprecisely located or moving target.

DESCRIPTION: A proof-of-concept is sought for a method of computing an optimal search pattern over terrain. It is assumed that a temporal probability distribution of target(s) locations is given. The interaction of sensor with the terrain will cause the search swath to vary. Thus sensor characteristics (swath,depth-of-view, weather effects), terrain and features (terrain masking, tree lines, bridges, ridge lines), sensor/target interaction (pixels on target), and the airborne platform's turning constraint must be considered in determining the effective search pattern. The definition of optimality should be user definable based upon time (or total pathlength), probability of target detection, and value of the target (in a multiple target scenario). A prototype implementation would be developed in C or C++ (commercial requirement) and would be able to run on equipment consistent with Navy combatant computer architectures.

PHASE I: Conduct a feasibility analysis study and establish the requirements (data, computer hardware, databases, and display technology) for performing an optimal covering, assuming only one target.

PHASE II: Expand on the Phase I study to include multiple targets and multiple airborne platforms and implement a prototype to demonstrate the concept. Of interest would be the computing time requirements, since the ultimate goal would be to perform this operation in near-real-time, e.g. seconds.

PHASE III: Enhance the prototype to accept real-time data and integrate it to communicate with existing and under development military systems.

COMMERCIAL POTENTIAL: Search and rescue operations, logistics enhancement, and delivery route optimization.

REFERENCES: The Tactical Movement Analyzer (NSWCDD/TR-94/99).

N96-035 TITLE: Innovative Approaches to Unmanned Aerial Vehicle (UAV) Detection of Minefields

OBJECTIVE: The use of land mines in regional conflicts has become a significant threat. The objective of this effort will be to investigate and demonstrate innovative approaches to minefield detection that are capable of being hosted on a UAV platform. Detection system can be used commercially to locate artifacts, buried items and precious metals.

DESCRIPTION: This effort will study the use of UAVs with Ground Penetrating Radar's (GPR) and advanced signal processing techniques to detect the presence of minefields. Innovative approaches must address current GPR limitations of limited range detection, clutter suppression, and object recognition. Innovative approaches must be capable of being implemented as an UAV payload. Based on study results, a prototype of an UAV minefield detection payload system will be fabricated and demonstrated.

PHASE I: Develop a UAV minefield detection concept that addresses traditional GPR limitations. Conduct laboratory performance measurements that validates concept viability.

PHASE II: A detailed design of a UAV minefield detection payload and ground processor system will be developed.

This design will maximize the use of existing system equipment and off-the-shelf' hardware and software. A prototype of the minefield detection system will then be fabricated and demonstrated in a realistic field exercise. Data will be gathered to validate minefield detection performance.

PHASE III: Transition to advanced development for use in commercial and military ground search systems

COMMERCIAL POTENTIAL: The non DoD and commercial potential to use UAVs to support worldwide minefield clearing operations is significant.

REFERENCES: ASTAMID Mission Need Statement, Cards Reference No. 0592

N96-036 TITLE: Unmanned Aerial Vehicle(UAV) Cellular Phone Relay For Distributed Command, Control And Communication And Intelligence Dissemination

OBJECTIVE: Develop a low cost/lightweight cellular phone relay system for UAV.

DESCRIPTION: Future military operations involving highly mobile forces ashore will require communications that must be flexible and reconfigurable to meet rapidly changing command and control requirements. Deployment time, terrain limitation, distance, responsiveness, and survivability will heavily tax the capabilities of available communication extension assets. The UAV based communications relay system can provide a cost effective, re-usable and flexible means of connecting widely dispersed tactical units. Commercial cellular phones can be adopted as a warrior's personal communications tool. Expeditious information exchange between various users including voice, data, facsimile, and freeze frame imagery is possible utilizing the existing commercial technology. In the theater of operation where the mobile phone infrastructure does not exist and is very time consuming or costly to set up, the UAV based cellular relay can serve as a highly effective personal communications system to quickly interconnect hundreds of users across the battlefield. The UAV cellular relay system will be comprised of three segments: airborne relay, ground support segment, and many individual mobile phone elements. The ground support segment co-located with the UAV ground controller, will be connected to the commercial telephone exchange and/or defense data network and fed into the mobile base station. The UAV airborne relay will serve as switching/broadcasting range extension system in connecting many mobile subscribers. It will allow the commanders to reach out to any suitably equipped lower echelon force for effective command and control, while a small tactical unit can assess the intelligence database rapidly within the theater and ask for combat service and fire support.

PHASE I: Investigate the adaptation of cellular communication technology for UAV applications. Conduct a feasibility study and perform architecture definition, technology trades and requirements analysis.

PHASE II: Develop prototype hardware, and demonstrate a UAV based cellular communication relay system which must be low cost and easy to deploy by the troops.

PHASE III: Produce the complete UAV cellular communications relay system and market the product.

COMMERCIAL POTENTIAL: The UAV cellular communications relay can be used to restore/reconstitute mobile phone service as an immediate replacement for lost cell towers, and to coordinate disaster relief/search and rescue effort during Federal Emergency Management Agency (FEMA) operations, etc.

REFERENCES: UAV Master Plan 1994

N96-037 TITLE: Reconfigurable Antenna Using High Temperature Superconductor

OBJECTIVE: Demonstrate a reconfigurable antenna using High Temperature Superconductor.

DESCRIPTION: The transition in High Temperature Superconductors (HTS) from the normal to the superconducting state has been shown to be achievable and fast with optical power. Using this phenomena, a reconfigurable antenna could be created to allow for a multifunctional antenna system in a relatively small size and weight package. HTS wafers of up to six inches are becoming available on the open market. New advances in small size lasers could reduce the size and weight of the system. HTS used at VHF frequencies can effectively decrease the size necessary for good performance at low frequencies. Any and all methods for creating a reconfigurable antenna using HTS should be considered.

PHASE I: Develop sufficient data to demonstrate feasibility of an innovative reconfigurable design using HTS as the transitioning material. Provide a report describing the demonstration antenna and possibilities for its system functionality.

PHASE II: Fabrication and demonstration of a reconfigurable HTS antenna. Provide a definition of and enough data to prove the antenna's system functionality.

PHASE III: Integration of the demonstrated antenna into a selected system for demonstration.

COMMERCIAL POTENTIAL: The multifunctional potential of reconfigurable antennas could reduce the size and weight of commercial satellite communications systems, thus reducing launch costs.

REFERENCES:
1. MTT 39(9), 1499-507
2. IEEE Trans. Appl. Supercond., 3(1)2848-2851,1993

N96-038 TITLE: On-Focal Plane Processing Techniques for Infrared Detector

OBJECTIVE: Develop innovative on-focal plane electronic processing architectures to improve the information bandwidth and data relevancy of today's advanced infrared focal plane arrays.

DESCRIPTION: Currently available infrared focal plane arrays produce massive quantities of data which must be processed in order to make use of the actual target-based information contained in the imagery. Such a large volume of data, if handled by conventional computing resources poses a stressing condition on such computers, and increases the cost, weight and power of resulting systems. Innovative processing architectures are sought to improve the relevancy of data produced from such arrays. Other potential results of this work could be improvements in application-specific tasks to which these new architectures are applied (i.e., spectral processing, FPA non-uniformity correction, target typing, etc.).

PHASE I: Perform a feasibility study which asserts a technique for on-focal plane processing, and perform preliminary designs and performance evaluations for such architectures. The on-focal plane processing techniques advanced must indicate a path to producibility of such devices in following phases of the program.

PHASE II: Develop, test and operationally demonstrate a prototype system which makes use of an on-focal plane processing operation in the satisfaction of a well-defined application. The performance parameters to be demonstrated would conform to those asserted in the Phase I portion of the program, and a path to dual-use commercialization of the instrument or technology should be firmly established.

PHASE III: Coordinate efforts to manufacture instruments which make use of on-focal plane processing techniques which would result in systems which may be made available to a variety of military applications.

COMMERCIAL POTENTIAL: Miniature hand-held imaging and processing systems resulting from the incorporation of on-focal plane processing architectures would find applications in a wide variety of commercial applications including hand-held infrared imaging spectrometers, instruments which may be programmed to detect fugitive emissions, clutter-suppressing detection systems for early warning night vision applications, etc.

N96-039 TITLE: Miniature Tunable Mid-Infrared Laser

OBJECTIVE: To develop a miniature, high peak power, high repetition rate, tunable mid-infrared laser.

DESCRIPTION: This project will develop an all solid-state powered miniature laser emitting in the 1.5-3.5 micron spectrum. The laser will be capable of high repetition rates up to 25KHz, producing multi-kilowatt peak power pulses.

PHASE I: The contractor shall provide a feasibility study which analyzes the tradeoffs affecting the design and performance of such a laser. The extension of the passband out to 5 microns should also be considered. The contractor shall provide a prototype design for the laser, with documentation of the design and the related theory.

PHASE II: During Phase II, the contractor shall construct and demonstrate a working laser. The laser shall emit in the 1.5-3.5 micron spectrum at pulse repetition frequencies of 25 Khz. The individual pulse peak power shall be in the kilowatt regime.

PHASE III: This technology has applications in both the countermeasure arena as well as the weapon seeker and fuzing arenas. In Phase III, integrate the technology into a fieldable system for one or more of these applications.

COMMERCIAL POTENTIAL: The medical industry is actively developing laser sources in the 2 micron spectrum. There are also numerous systems fielded that use the coherent nature of laser light to measure wind velocities and wind shear.

Wavelengths longer than 1.5 microns are typically considered eye-safe for these applications. The laser developed under this program would, therefore, be suitable for unrestricted commercial use.

N96-040 TITLE: IR Target Polarization Discriminator For IR Seekers

OBJECTIVE: Provide via electronic and optic means IR polarimetric measurement capability on the surface of IR detectors for target feature discrimination. A stokes parameter determining filter will be interposed in the optic field before the detectors to alter the IR detection. The filter has electrically controllable capabilities that are used in conjunction with the IR digital processor to extract target features such as skin location, engines, plumes, and hot spots.

DESCRIPTION: A wafer sandwich of polarized filter material with pass band in the near, mid and far infrared regions that has multiple layers of electronically selectable polarization material at 0° 90° and 45° is inserted in the optical path just before the cold shield or on the surface of the detector array. For scanning arrays the filter should be stationary. Polarizing material is built on to the detectors for horizontal, vertical, cross and cross polarization delayed. The polarization filters are placed in either optical beam for all pixels or for adjacent pixels or on each pixel. Polarization is selected electrically. Pictures are taken in each polarization state and the stokes parameters computer, 3 stoker parameter pictures were created for each scene. The filter polarization preference is commanded by the IR Digital Processor and the stokes parameters computer. Then alternate IR scene frames are subtracted such as U-V to extract specific IR scene features. Hot burning gases are randomly or circular polarized, thus 0° linear polarized detection level when subtracted from a 90° polarized detection level yields a small residual of the burning gas but retains the linear polarized IR energy emanating from the low graze angle portions of target surfaces. Thus the high energy random clutter signal is removed from the scene and other distinct target geometric features retained.

PHASE I: Research literature and Naval development reports for IR polarimetry materials, measurement and studies. Construct a digitally commanded filter for stokes parameter and polarization measurement of IR emanations by focal plane array and scanning array IR detectors. The digital controlled filter should have two polarization states for each polarization layer - selected polarization preference and no polarization preference. If materials with at least bistate polarization selectability are not available then digital selection of fixed polarization preference modified pixels in the array will be used. The required software and hardware to perform the stokes parameters and differential polarization computations shall be developed. The developer shall build up a suitably modified IR focal plane array or a suitable optical filter for placement in the optical path of a IR focal plane array or scanned array of IR detector. An installation of suitable optics for laboratory demonstration shall also be provided. The number of pixels shall be sufficient for measurement of target parameters, for example 64 by 64. The IR bandwidth shall include a region in 2.9 to 5.2 micro meters or 8 to 12 micrometers.

PHASE II: Develop test and operationally demonstrate for the Weapons community an IR target polarization discriminant IR detector and optics. The detector and optics shall be sufficiently developed that it can be installed in weapons seekers with minimal modification. The software and software shall be developed to a state of readiness that airborne trails can be performed to tailor the design to the tactical need. Documentation shall be sufficient the design can be incorporated into some existing weapon system.

PHASE III: Design and manufacture an IR target polarization discriminant seeker for use in a Naval Weapon system. Design and manufacture components for an IR polarization discrimination module for installation in Naval weapons systems as a subcontracted item.

COMMERCIAL POTENTIAL: This IR polarimetric component is readily employable in manufacturing process control and as an imager for robotics and machine control.

REFERENCES: "Fundamentals of Infrared Detector Operation and Testing", by John David Vincent, Wiley Interscience publisher. Project Long Jump, NAWCWPNS, China Lake CA., 1988-1990. Infrared Polarimetry for Target Discrimination and Polarimetric Components Testing, Dr. Soe-Mie F. Nee, 6/94, NAWCWPNS, China Lake, CA.

N96-041 TITLE: Digital GPS Translator Ground/Remote Based Processor

OBJECTIVE: Develop a low cost, accurate, fast GPS digital translator ground based processor system.

DESCRIPTION: Current ground based GPS digital translator computer processors, using differential corrections, are large, non-portable, and prohibitively expensive. There is an immediate need for a low cost, small, portable, IBM PC or compatible based, ground based GPS digital translator processor for real time and post-mission vehicle trajectory calculations. The

processor system should be capable of processing digital translator GPS and differential correction data and producing a state vector type output at a 30 Hz rate for each highly dynamic, tracked weapon or vehicle. The system should be able to process and output this state vector type data for 10 different tracked objects. The processor system should have the capability of functioning as a stand alone, remotely operated system with its own display system, power director/uninterruptable power supply, and human interface devices such as keyboard and mouse.

PHASE I: Perform a feasibility study of applications of new technologies to improvements to GPS data processors, more efficient algorithms and software design, and determine and identify hardware to meet these requirements.

PHASE II: Develop a bench top prototype processing system using proposed hardware and software and demonstrate that the system meets requirements using digital GPS translator inputs.

PHASE III: Develop, package, and deliver a complete digital GPS Translator Ground/Remote Based Processor System as required including full documentation, sources of all commercial software and hardware, algorithms, and new software source code to the Government.

COMMERCIAL POTENTIAL: GPS application technologies in both the government and commercial sectors are widely needed. This system could be used to track and locate both government (military) and commercial (civilian) aircraft, water craft of all sizes, trucks, cars, and trains (manned or unmanned).

N96-042 TITLE: A Robust Real Time Kinematic Differential Global Positioning System (KDGPS) Algorithm for High Dynamic Vehicles (7-11 G's)

OBJECTIVE: Provide a real time algorithm to generate KDGPS data using carrier phase data for submeter Time Space Position Information (TSPI) data in real time.

DESCRIPTION: Present high dynamic real time local differential GPS systems rely primarily on inertial aided code GPS data, e.g. Range Application Joint Program Office (RAJPO) GPS. This and other systems provide accuracy data at two meters RMS in the horizontal, four meters RMS in the vertical, a nominal signal-to-noise ratio of 38 Db-Hz, a nominal Horizontal Dilution of Precision (HDOP) of 1.5, and a Vertical Dilution of Precision (VDOP) of 2.5 at 9 G's. Given the improvements to GPS capabilities of the Joint Program Office (JPO) and other commercial GPS systems that are imbedded on Tactical vehicles, these levels of accuracy are no longer adequate for use as a test measurement system for test and evaluation ranges. The application of carrier phase KDGPS processes that have demonstrated accuracies at the decimeter level are needed. The effort will provide a robust algorithm and a system to use carrier phase processing for high dynamic vehicles and will provide decimeter horizontal and vertical accuracies at the above-specified conditions.

PHASE I: Provide a feasibility study which develops an algorithm to provide real time KDGPS data, carrier phase GPS data, and identifies the hardware that this algorithm will need to provide the required data. This algorithm should be robust, modular, and have an open architecture design to facilitate integration into high dynamic test vehicles.

PHASE II: Develop, document, test and operationally demonstrate the algorithm formulated in Phase I of this SBIR on a prototype assembled system.

PHASE III: Provide a fully documented and operating algorithm and system demonstrated in Phase II.

COMMERCIAL POTENTIAL: This algorithm can be use by geophysical companies for mapping and precise location of resources.

REFERENCES: Lachapelle, Cannon, Lu, Ambiguity Resolution on the Fly- A Comparison of P-code and High Performance C/A Code Receiver Technologies. Proceedings US Institute of Navigation (ION), Albuquerque, NM, 16-18 September 1992.

N96-043 TITLE: Near-Field Radar Signature Modeling for EW/End-Game Simulation Applications

OBJECTIVE: Develop A Near-Field Computer-Aided Radar Signature Model for Radar-Guided Weapon Systems ECM/End-Game Simulation Analysis.

DESCRIPTION: Existing near-field radar cross section (RCS) computation algorithms are typically based on first-order high frequency methods, which do not take into consideration the multiple-bounce and mutual shadow effects. In particular, those algorithms can not be used to calculate scattering from a cavity such as an engine inlet or a sensor box. However, the cavity scattering and material coating are known to be crucial contributors in fuzing and ECM end-game scenario. Their inclusion in

the computer simulation modeling is thus a must.

PHASE I: To explore and identify near-field modeling techniques; provide an innovative plan for solving the above problems; and deliver a near-field RCS computer software that contains as many of the above features as possible.

PHASE II: To complete the development of the near-field modeling software with all the features included; verify its validity; and package it in a user-friendly, menu-driven form with detailed manuals.

PHASE III: Interface with government furnished software and demonstrate the operation of algorithms in an synthetic virtual environment for EW effectiveness evaluation.

COMMERCIAL POTENTIAL: This research and development effort has potential application to collision avoidance of commercial aircraft.

N96-044 TITLE: Very Low Bit-Rate Error-Resilient Video Communication

OBJECTIVE: Develop a reliable real-time video communication system suitable for channels with a limited bandwidth.

DESCRIPTION: The primary focus of this project is on exploratory development of incorporating error resilience and error concealment technology in the state of art video compression technology. The algorithm should have the ability to compress the image at a bit rate comparable to the current MPEG standard, while being robust against channel error rate ranging from 10-2 to 10-5. The algorithms should be run on commercially available image and signal processing hardware for the speed of development and minimization of cost. The real-time video compression platform should also be easily upgradeable for increased resolution and frame rate.

PHASE I Explore and identify cooperative channel and source coding scheme
develop the-state-of-art low bit rate video coding, and provide an innovative error localization and concealment technology

PHASE II Apply the techniques developed in Phase I and create prototype hardware for feasible demonstration with real video test data.

PHASE III Demonstration of the developed hardware in existing Navy Tactical Aircraft, and technology transfer to commercial applications.

COMMERCIAL POTENTIAL: This research and development effort has great potential for mobile multimedia communication, cellular videophone, wireless video link, deep space video transmission, etc.

N96-045 TITLE: Biodegradable Batteries

OBJECTIVE: To develop a new type of battery that is biodegradable in the marine environment.

DESCRIPTION: Batteries, both rechargeable and disposable, are generally tossed out after use, even though many contain hazardous materials. Recent battery development work has identified the potential of using polymers for the electrolyte and cathodes in batteries. Simultaneously, research has shown the potential of forming polymers that are biodegradable. The combination of these technologies would result in high capacity biodegradable batteries.

PHASE I: Investigate battery technology and biodegradable polymer technology to identify materials that could be suitable for battery components, and that will degrade after use in the marine environment or with land disposal. Develop a strategy for biodegradable material replacement for batteries that will maintain or exceed the ampere-hour ratings, voltage, and voltage vs. percent discharge ratings of existing batteries both on a per mass and per volume basis Priority is for disposable batteries; replacement in rechargeable batteries is a secondary goal.

PHASE II: Demonstrate the effectiveness of using biodegradable materials in battery test cells and demonstrate the biodegradability of the materials.

PHASE III: Develop into useable biodegradable batteries.

COMMERCIAL POTENTIAL: There is a vast commercial market for both disposable and rechargeable batteries. Improper disposal of current batteries causes environmental harm while proper disposal as hazardous materials substantially increases their costs. Biodegradable batteries would have similar purchase cost to current batteries, but require no special treatment for disposal.

REFERENCES:
1. Abraham, K.M. and M. Alamgir, "Room temperature polymer electrolytes and batteries based on them," Solid State Ionics 70/71 (1994), pp 20-26, North Holland/Elsevier.
2. Freemountle, M., "Organic Cathode Spurs Battery Energy Storage", Chemical & Engineering News, pp 5-6, 20 February 1995.
3. Meyer, J.M. and D.L. Kaplan, "Biodegradable Materials: Balancing Degradability and Performance", Trends in Polymer Science, Vol 2 No. 7, July 1994, pp 227-235.
4. Apler, M., et. al. ed, "Biomolecular Materials by Design", Vol 330 (1993 MRS Fall Meeting, Boston, MA), Materials Research Society, 1994, ISBN 1-55899-229-4.

N96-046 TITLE: Common Modularized E-O Sensor Payload

OBJECTIVE: The objective of this topic is to develop a reconfigurable sensor payload for multiple Naval platforms which is upgradeable to include laser radar (LADAR) systems as well as infrared sensors.

DESCRIPTION: Present Forward Looking Infrared (FLIR) systems are highly specific to a given platform and are not interchangeable between platforms nor easily modified with different sensors as new technology becomes available. There is a need to develop a modularized E-O sensor payload that can be easily reconfigured with new sensors and has a growth capability to add new sensors to existing equipment within the payload.

PHASE I: Develop the conceptual design for a modularized E-O sensor payload incorporating the latest staring mid-wavelength infrared technology appropriate for Navy operational conditions. The payload shall be designed in a fashion that easily permits modifications of or replacement of the FLIR, addition of laser range finder/designator, and includes the capability of upgrading the system to add a LADAR for μ-Doppler non-cooperative identification.

PHASE II: Develop a prototype airborne system reconfigurable for multiple Naval platforms.

PHASE III: Implement the technology developed into a fieldable system.

COMMERCIAL POTENTIAL: A modularized E-O sensor payload would enable lower cost, more flexible implementation of E-O sensor suites used by law enforcement agencies. Payloads could be replaced or upgraded without replacing the entire payload, resulting in significant cost savings.

N96-047 TITLE: Moveable Focal Plane Array (MFPA) for Compensating Aircraft Forward Velocity

OBJECTIVE: To significantly reduce the complexity and increase the performance of high pixel density Focal Plane Arrays (FPA) used in imaging sensors

DESCRIPTION: Provide Forward Motion Compensation for FPA type sensors used in high performance, reconnaissance aircraft. In addition, compensation shall be implemented for random motions due to vibrations and other inflight perturbations. Powerful processing techniques are presently utilized to perform this function but have inherent limitations. Simplified kinematic/electromechanical approaches are to be considered.

PHASE I: Develop a conceptual design for an MFPA that involves performance modeling of a generic airborne optical sensor system. Modeling shall address the benefits and assess tradeoffs associated with varying the design parameters of the MFPA. A design shall be implemented that illustrates the detailed approach developed for achieving the required performance. System/subsystems/component and concepts shall be developed and tradeoffs shall be defined for selecting the optimum design approach that validates the objectives of this effort.

PHASE II: Develop a prototype array for integration into a Naval platform

PHASE III: Implement the technology developed into a fieldable system

COMMERCIAL POTENTIAL: This technology would have commercial application to Law Enforcement and the need to provide accurate evidentiary materials for prosecution. Cartographic, high acuity imagery would now be attainable in a digital format, that has been heretofore, unachievable. In addition, the availability of high resolution, multi-spectral imagery would have application to land resource managers, environmental protection, urban planning projection tool, and any commercial need for real-time, high resolution imagery collected in an airborne platform.

N96-048 TITLE: Tunable MWIR Hyper-Spectral Imaging for Low Observable Target Detection from an Airborne Platform

OBJECTIVE: The objective of this topic is to demonstrate improved target detection capabilities for mid wavelength infrared (MWIR) imaging systems using tunable hyper-spectral techniques.

DESCRIPTION: The low observable target, such as a sea skimming or terrain following missile, have a contrast ratio that varies significantly over the diurnal cycle. Detection of targets that are buried in sea and ground clutter can be enhanced with the use of infrared hyper-spectral tunable imagery. Hyper-spectral imaging involves dividing the total spectral sensitivity band of an imaging system into several spectral sub-bands, and collecting the imagery from each. Various image processing techniques that compare the images in the sub-bands is performed to detect features or targets that have very low contrast in the total spectral sensitivity band. The objective of this effort is to develop a new and innovative airborne MWIR hyper-spectral imaging system that can be adaptively tuned over the diurnal cycle to the spectral band where the signal to clutter ratio is maximized. This sensor will be flown on the Navy's P-3 Airborne Test Bed and evaluated against low observable targets buried in deep clutter.

PHASE I: Develop a conceptual design for a tunable MWIR hyper-spectral imaging system utilizing the latest staring focal plane array technology that can be integrated into the optical station on the Navy's P-3 Airborne Test Bed.

PHASE II: Develop a tunable MWIR hyper-spectral imaging system, integrate it with the optical station on the Navy's P-3 Airborne Test Bed, and perform airborne evaluation of the system against low observable targets buried in deep clutter.

PHASE III: Transition the system to the fleet as well as to the consumer market place.

COMMERCIAL POTENTIAL: This technology has many applications in the commercial market such as environmental and resource monitoring, bioflouoscopic surgical instrumentation, auto exhaust emissions monitoring, etc.

N96-049 TITLE: Software Metric To Predict Real-Time System Throughput

OBJECTIVE: The objective of this research will be to develop a software metric(s) that can be used to predict via indirect means the throughput of a real-time system early in its development.

DESCRIPTION: DOD has repeatedly experienced cost overruns and long schedule delays on mission critical software projects when it is found that the real-time task timing requirements can not be met. DOD has mandated software reserve requirements be budgeted and monitored. Budgeting is done in the requirements and design phases; however the monitoring is done in the system integration phase when actual code is available for direct measurement. When a throughput problem is found this late in the product development or inevitably causes cost overruns and schedule delays. A method is needed to predict the throughput problems earlier to maintain cost and schedule.

PHASE I: Development of the theory behind what a throughput metric will be measuring and how that relates to the throughput that is being predicted. Development of set of software metrics based on the theory. Select a set of software complexity metrics and random metric that will enable a double blind experiment. Perform a double blind experiment using the metrics on a set of small homogeneous software programs. A set of undergraduate software projects could be used for this purpose. report on the strength of the inference between what software characteristics each of the metrics measured and the indeterminate throughput the metric is predicting. Select a set of real world Navy real-time software development projects for further experimentation that will provide a broad exposure for the metrics i.g.; Ada and other high level languages, large and small software development projects, standalone and embedded systems.

PHASE II: On Navy projects selected in Phase I, gather, analyze, test and demonstrate the robustness and effectiveness of predicting throughput problems. Perform the same double blind type experiment done in Phase I.

PHASE III: Produce automated metric extraction tools for both military and commercial software development environments. This will be the transition point into Navy software development projects.

COMMERCIAL POTENTIAL: A metric tool developed from this research can be used in commercial real-time software development.

REFERENCES: DOD-STD-2167A

N96-050 TITLE: Prototype Transition Environment for Complex Software Systems

OBJECTIVE: Perform research for development of a software development environment which supports a smooth transition between rapid prototyping and full-scale development for large complex systems. Perform research leading to refinements of the environment which optimize maintenance activities for such systems.

DESCRIPTION: It has been proposed that user interface development tools (UIDTs) can be used equally well for rapid prototyping and full system development; it has been further proposed that such tools can accommodate a smooth transition between these two activities. While several such tools have shown adequate support for these activities for small scale, single-application systems, no corresponding demonstration has been made for large systems. Indeed, such tools are notorious for their inability to scale up to the multi-user, multi-application, even multi-language requirements of large Government systems. Recent technology developments suggest that a certain class of UIDT, that of user interface management systems (UIMSs) may offer significant improvements in the development and maintenance of such systems. Research areas include: methods of defining prototypes for large systems; techniques affecting the transition of such prototypes into delivered systems; study of the special facets that are unique to the large system development and maintenance problem; and techniques for accommodating these facets.

PHASE I: Phase I will result in concept papers, proof-of-concept, and detailed project plans for the remainder of the project.

PHASE II: Phase Ii will result in a fully-functional prototype of the development/maintenance environment, with a preliminary evaluation of its efficacy in supporting the stated objectives.

PHASE III: During Phase III, the system will be put into project use.

COMMERCIAL POTENTIAL: Government agencies spend billions of dollars annually on the development of large, complex software systems, and even cannot be overstated. Any development environment that can pare the cost of developing and maintaining such systems would be of benefit to literally hundreds of Government contractors looking to hone their competitive edge. Benefits can also be immediately realized by such an environment in domains in the private sector, such as banking, process control, and health care.

REFERENCES:
(1) Bass, L., Coutaz, J., DEVELOPING SOFTWARE FOR THE USER INTERFACE, Addison-Wesley, Reading, MA, 1991
(2) Hardy, EJ, Klein, DV, "The Serpent UIMS," in Proceedings, EUUG Autumn 1990 Conference, Nice, France, October 1990
(3) Klein, D. V., "Developing Applications with a UIMS," in Proceedings, USENIX Application Development Symposium, Toronto, April 1994.

N96-051 TITLE: Advanced SAR Processing Techniques

OBJECTIVE: The objective of this topic is to improve SAR processing, particularly in the low frequency UWB/UHF region, through new and novel analysis and processing techniques.

DESCRIPTION: Synthetic Aperture Radar (SAR) imaging is being used increasingly in a broad spectrum of all-weather military and nonmilitary applications. Bands of interest include X band but also include greater interest of late in the Ultrawide Band (UWB) UHF frequency range. Areas of importance to the Navy littoral surveillance mission span from wide area surveillance and target cuing to target ID and accurate geolocation. Also of increasing interest are terrain characterization and mapping, particularly in rugged forested regions for military as well as commercial and environmental application. As the spectrum of potential geographic regions of interest grows, more robust analysis, processing, and modeling techniques are required in order to accurately characterize targets and clutter in the respective terrain environments. Novel, robust analysis approaches to optimal focusing, statistical characterization, RFI/interference rejection (particularly for low frequency foliage/ground penetration systems), and image formation/registration will be of greatest interest and impact for future systems.

PHASE I: Explore new and robust modeling and analysis techniques in order to demonstrate the greatest feasibility of improving the SAR image formation process and image product with the overall goal of extracting optimal information from terrain scenes over various littoral region types. As a minimum, algorithms should be provided, preferably with prototype codes, for demonstration of feasibility and evaluation.

PHASE II: Using the technique(s) developed in Phase I, extend and improve the design(s) for robust performance over a variety of terrain and target types. Quantitative performance measures will be developed and applied for comparison to current/conventional techniques over diverse sets of government supplied SAR data.

PHASE III: Transition algorithms and techniques into ongoing projects, both military (e.g., ONR, ARPA, NAVAIR, etc.) and nonmilitary (e.g., environmental and/or commercial).

COMMERCIAL POTENTIAL: The utility of low frequency SAR is only now emerging as an important remote sensing tool for environmental as well as disaster response applications. The ability to penetrate foliage, and to some extent the ground, could have profound impact in some areas such as forest wetlands management, geological/resource exploration, and law enforcement (in terms of counter drug surveillance in remote regions). Robust imaging techniques will be required in order to extract optimal information from this data.

REFERENCES: "Proceedings of SPIE AeroSense Conference, Algorithms for Synthetic Aperture Radar Imagery II," Spie Proceedings Vol. 2487, 19-21 April 1995, Orlando, Fla.

N96-052 TITLE: Helicopter Onboard Sensor Training

OBJECTIVE: Develop an embedded advanced helicopter onboard sensor training system.

DESCRIPTION: Currently, US Navy aircrews of multi-mission aircraft receive ground based training in the operation of helicopter onboard sensor systems. As sensor systems become more complex, the volume and complexity of the ground training must increase and proficiency becomes increasingly perishable. By embedding intelligent training software into the onboard sensor systems, it is possible to develop a comprehensive interactive learning aid for advanced training and regular refresher training while deployed. The Navy desires to develop such a supplemental training system embedded into helicopter sensor display systems. The benefits of this effort will be an increase in aircrew situational awareness, overall system knowledge, and mission effectiveness.

PHASE I: Provide a feasibility study which develops an intelligent training system embedded in onboard sensor systems for helicopter aircrew. The system shall be designed to stimulate tactical displays with simulated tactical information as an overlay to real world data. The study shall investigate systems requirements for intelligent, multimedia, embedded training systems, investigate alternative system architectures, and include a preliminary design of the embedded training system.

PHASE II: Develop a prototype of the intelligent embedded training designed under the PHASE I SBIR effort. Demonstrate stimulation of an aircraft sensor with simulated threat data overlaid onto real world environmental data for display on actual tactical gear. This should include an embedded lesson that demonstrates how operator proficiency can be improved by embedded training. The selected sensor for this demonstration should be FLIR (with laser designator), ESM, acoustics or radar.

PHASE III: Produce variants of the PHASE II embedded training system for various Navy ASW aircraft platforms.

COMMERCIAL POTENTIAL: This embedded training system architecture will be of great value to the US Navy maritime patrol and ASW communities, US Air Force surveillance communities, and commercial heavy industry. Incorporation of this technology into heavy industry would enhance on the job training achieving increased trainee performance at reduced cost.

N96-053 TITLE: Interface Unit Enabling Utilization of Aircraft Tactical Tape in Aircrew Simulators

OBJECTIVE: Provide a cost effective alternative to the traditional methods used by the Navy for making software transitions from aircraft to cockpit simulators. Current methods require redundant development efforts which are costly and time consuming.

DESCRIPTION: The Navy has an interest in reducing the cost of maintaining its cockpit simulators to provide cost effective tactical man-in-the-loop simulation, mission planning and rehearsal. The problem with existing simulators stem from the lack of portability of software developed for the parent aircraft -- to aircrew simulators. It currently takes an inordinate amount of time and money to make this transition. When a software update is being implemented in the aircraft, a parallel effort is on-going for the affected simulators. This proposal will develop and prototype an interface unit which allows aircrew simulators to utilize their respective aircraft tactical tape.

PHASE I: Phase I will consist of a front end analysis to determine functional requirements and technical feasibility of the interface unit. Existing cockpit simulators will be studied to define the technical design requirements of the interface unit.

PHASE II: A prototype interface unit will be designed, built and tested for a single aircraft type.

PHASE III: The prototype that was designed and tested in phase II will be expanded and implemented in various other simulator types, possibly including a ship and a tank.

COMMERCIAL POTENTIAL: The interface unit could serve as a prototype training system for the Navy as well as for other DoD components. Since the system will be highly portable, its application will be applicable to all types of aircraft. Tremendous cost savings potential will be realized by reducing simulator software development for all types of DoD and commercial simulators including aircraft, ship, and command & control centers.

REFERENCES: Marc Robs, Cockpit Technology Forms Swift Roller-Coast Ride, National Defense Journal, vol. 78, Nov. 1993. Ray Braybrook, The Cockpit of the Future, Military Technology and Economics, vol.4, no. 17, 1990. William B. Scott, Simulator Flight Tests Validate Integrated Pictorial Cockpit Display, Aviation Week and Space Technology, vol.130, no. 2, Jan. 9, 1989.

N96-054 TITLE: Portable Tele-training/Technical Assistance

OBJECTIVE: Develop the means to conduct tele-training and technical assistance for ships at sea and other mobile users.

DESCRIPTION: The Navy relies extensively on the costly and time consuming use of technical representatives and on-site support to provide technical assistance in maintaining critical ship systems and training/technical support when introducing new or modified systems. Equipment failures that cannot be repaired by onboard personnel results in lost operational capability until technical assistance can be obtained. Training for personnel on deployed ships is limited to onboard assets or to generic training broadcasts. Training needs to be tailored to the ship's operational requirements and the specific needs of the crew. Advances in video tele-conferencing and information technology provide some of the tools that could enable real-time (or near real-time) training and technical assistance to deployed ships and other mobile users. However, the limiting factor is connectivity. Limited satellite availability, coverage, and bandwidth pose serious constraints. Some initial attempts at providing a satellite pipeline to a ship at sea have also highlighted reliability problems. This effort will provide a reliable and affordable means of providing two-way video, voice, and data connectivity with ships at sea and other mobile users.

PHASE I: Provide a feasibility study which develops a method (or methods) of providing reliable and affordable video, voice, and data connectivity with ships at sea and other mobile users to enable portable tele-training and technical assistance. The method(s) must be compatible with existing ship's communications and data architectures and should allow coverage for most potential deployments using existing and planned satellite systems.

PHASE II: Develop, test and operationally demonstrate the method(s) formulated under the Phase I SBIR effort.

PHASE III: Produce the tele-training and technical assistance method(s) demonstrated in the Phase II effort. This will be the transition into the Navy's distance learning and logistics programs.

COMMERCIAL POTENTIAL: Many corporations are now geographically dispersed and employ a world wide network of field service providers. New video, voice, and data connectivity methods will link them with their organizations for training, technical assistance, and data exchange. Current landline and cellular systems lack the bandwidth and coverage to provide adequate coverage, particularly when video is required. This same technology can be used to provide connectivity to emergency medical service personnel in the field, particularly in remote areas, to provide assistance with diagnosis and treatment (tele-medicine).

N96-055 TITLE: Software Package for Speaker Independent or Dependent Continuous Speech Recognition

OBJECTIVE: Adapt or develop a software application to replace existing air traffic control (ATC) trainer hardware for speaker dependent continuous speech recognition.

DESCRIPTION: Air traffic control is critical to carrier battle group and amphibious war fighting operations. The Navy trains approximately 1600 air traffic controllers per year. Due to the volume and critical nature of this training, it is very important to use innovative technology to improve training and lower costs. Currently, a combination of software and high performance hardware is use to provide speaker dependent continuous speech recognition in ATC trainers. Speaker independent continuous speech recognition is desired. However, a portable all software implementation of speaker dependent continuous speech recognition would be a significant improvement over the current hardware/software implementation.

PHASE I: Perform a feasibility study to determine if a software implementation of speaker independent or dependent

continuous speech recognition is feasible for air traffic control training with performance characteristics that exceed the technology that is currently use in ATC trainers.

PHASE II: Develop, test and operationally demonstrate the software application formulated under the Phase I SBIR.

PHASE III: Integrate the software application demonstrated in the Phase II effort into existing ATC trainers.

COMMERCIAL POTENTIAL: Commercial applications include civilian air traffic control training, law enforcement training, entertainment, and others.

REFERENCES: Phraseology for Navy Air Traffic Control, Documents relating to current voice recognition systems

N96-056 TITLE: Virtual Vertical Aircraft Signal Trainer (VVAST)

OBJECTIVE: Creation of a virtual environment which represents helicopter aircraft in taxi, takeoff, and landing phases of operations and which respond to hand gestures and/or spoken signals of the signal trainee directing the system.

DESCRIPTION: The Navy currently uses live helicopter operations to train Landing Signal Enlisted personnel in the signaling of vertical aircraft during taxi, takeoff, and landing phases of operations. Recently, cuts in the numbers of hours to be flown by pilots have put significant constraints on opportunities to train LSE personnel. In addition, the cost of training LSE personnel last year was $ 468,000.00 in flight time alone. Although the cost of developing a facility like that used to train Landing Signal Officers would be prohibitively expensive, it might be possible to develop a virtual system for a fraction of that cost. The system would have the advantage of reconfigurability inherent in virtual systems, such that various helicopters, vertical jump-jets, and other aircraft in taxi mode could be added as needed.

PHASE I: Provide a feasibility study which develops a method to represent a generic helicopter during operations, and which would respond to the hand signals and speech inputs of the trainee. The visual system should minimize the problems of depth perception and distance estimation that can occur in simulated displays. The development of a hand (or wand) tracker would be required, and the system should allow the user to move about an open area of about ten square feet as necessary - yet still be able to track their signals and respond appropriately. Additionally, the proposed method should be of a modular, open architecture design to facilitate upgrades and integration into the Navy's VETT Lab architecture.

PHASE II: Develop, test and operationally demonstrate the VVAST system formulated under the Phase I SBIR effort.

PHASE III: Produce the VVAST system demonstrated in the Phase II effort.

COMMERCIAL POTENTIAL: Training a variety of signal-persons in commercial settings, marketing of arm/hand trackers for other non-DoD applications.

REFERENCES: Naval Warfare Publication Nos. NWP-42 and NWP-19.

N96-057 TITLE: A Hybrid Immersive/Non-Immersive Virtual Environment Workstation

OBJECTIVE: Develop digital hardware and software technology to produce a hybrid virtual environment workstation which supports highly interactive immersive interfaces concurrently and in coordination with conventional high-resolution, flat-screen displays.

DESCRIPTION: In contrast to the traditional view of virtual environments which places the system operator in an immersive head-mounted display with spatial trackers for head and body motion, many relevant applications would benefit greatly from a hybrid system which supports both immersive and non-immersive interfaces concurrently. An example of this is in shipboard command and control where it is impractical to require an operator to remain immersed in a computer generated virtual environment for extended periods of time. While a virtual environment will enhance performance on specific spatial dominant tasks, conventional wide-screen displays will continue to be most effective for many Top-down or flat (two-dimensional or projected three-dimensional) views of data. The operator must be able to seamlessly switch from one display to the other making the essential and time-critical data available at all times. Furthermore, the users conceptual model of the system must be that of one unified system rather than two connected systems. Such a hybrid system must be able to operate in a confined area allowing it to be safely used in small spaces. It must allow the operator to navigate large virtual spaces efficiently but with fine control. The system must integrate spatial input with the displays. The spatial tracking system must be immune to external interference such as that from magnetic fields and noise. The display must be full color, high-resolution and wide field-of-view.

PHASE I: Provide a thorough investigation of potential solutions and develop a design which addresses the needs and requirements listed above. A report describing the proposed solution, its technical advantages over alternative solutions, and its expected performance specifications will be required.

PHASE II: Develop, test, and demonstrate the solution described under the Phase I effort.

PHASE III: Produce the system developed under the Phase II effort for general purpose applications.

COMMERCIAL POTENTIAL: Current technology constraints require system designers to choose between immersive environments and flat-screen through-the-window environments. A hybrid system combining the strengths of both allow designers to make use of immersive interface technology for visualization and interactions which most benefit from the spatial characteristics of virtual worlds while preserving the utility of flat-screen technology for non-spatial tasks. Such a system will serve to bring virtual environment technology to a wider range of applicable problem domains.

N96-058 TITLE: Weapons Impact Assessment Technology

OBJECTIVE: Decrease the time and cost required for strike commanders to obtain post-strike imagery of a target area.

DESCRIPTION: When assessing effectiveness of air strikes, a strike commander's ability to quickly determine weapon impact location in relation to the intended target is vitally important. Current Bomb Impact Assessment (BIA) methods depend on aircrew visual reports, aircraft forward-looking infrared tapes, visual and infrared photography from reconnaissance aircraft, unmanned aerial vehicles with sensors, and information gathered from national assets such as satellites. These methods are limited, imprecise, time consuming, and strongly dependent upon weather in the target locale. Near-future combat operations will be conducted with little regard for target area weather conditions. This situation will rapidly outstrip existing assessment system capabilities. Analysts will be unable to meet the requirements for timely and accurate restrike assessments and recommendations. A requirement exists for a non-intrusive, low-cost sensor/transmitter/receiver that can be adapted to existing and future weapons and weapons systems, which will transmit an image of the weapon impact site to the launch aircraft for recording and subsequent review within one hour after aircraft recovery. This effort will provide technology leading to a formal engineering development program to resolve the tactical limitations of today's theater-based BIA techniques.

PHASE I: Provide a study addressing the tradeoffs between costs and requirements for: (1) night time and adverse weather imaging; (2) data link range and robustness; (3) aircraft integration complexity; and (4) data marking for post-strike mission analysis. The analysis should address the infrastructure needed to support and use the weapons impact assessment concepts as well as the acquisition costs. Technology risk areas shall be identified and appropriate demonstrations for resolving risk areas shall be proposed as products of the study.

PHASE II: Develop the sensor/transmitter and receiver prototype devices for the preferred concept identified in the Phase I effort. Conduct component tests and analyze data to resolve key technological risks.

PHASE III: Fabricate prototypes with updated designs based on data gathered in the Phase II effort. Perform flight tests to demonstrate the feasibility and utility of the weapon impact assessment concept in a realistic operational environment. This technology will transition into the Joint Direct Attack Munitions program.

COMMERCIAL POTENTIAL: Low cost imaging sensor/transmitter technology can be used by news media, crisis response teams or other security or safety applications where visibility and hazards prevent normal video coverage.

REFERENCES:

(1) "Systems Acquisitions for Precision Air Strikes, " FY 1994-1999 Defense Planning Guidance
(2) USAF Surveillance and Reconnaissance Mission Area Plan
(3) Navy Strike and Antisurface Warfare Master Plan
(4) Draft Mission Need Statement for Bomb Impact Assessment (BIA) Capability.

N96-059 TITLE: Fuel Combustion Inhibitor (FCI) as a Non-Lethal Cruise Missile Payload

OBJECTIVE: Development of a cruise missile payload which can effectively inhibit combustion engine operation of an adversary's motorized military equipment (either on land or at sea) without adversely affecting personnel or the environment.

DESCRIPTION: The vast majority of weapons in the US Navy inventory are designed to deliver ordnance payloads which have destructive and/or lethal effects. Predicting the degree and extent of these destructive effects is often difficult, particularly when

targets are near civilian population centers. Accordingly, there is an emerging requirement for weapon payloads which can degrade an adversary's military capability while at the same time minimizing or eliminating the destructive effect on civilian populations. Since any effective military capability depends heavily on motorized equipment, a weapon payload which inhibits the operation of combustion engines would be highly effective. At the same time, such a Fuel Combustion Inhibitor (FCI) payload would have little or no destructive effect on civilian populations or property. The goal of this effort is the identification/development of a non-lethal FCI which can disable motorized equipment with little or no effect on personnel or the environment and that is deliverable as a cruise missile payload.

PHASE I: Analyze and describe the chemical characteristics and synthesis requirements for FCI compounds. Based on these postulated characteristics, estimate the quantity of FCI required for effective utilization and the feasibility of using cruise missiles as a delivery system. Perform an associated analysis to determine what countermeasures are possible to neutralize the FCI and what potential personnel safety and environmental impacts would be associated with the FCI. Perform a feasibility study for synthesizing small quantities of FCIs for test purposes.

PHASE II: Based upon the analysis and results of Phase I, synthesize samples of FCI compounds and conduct testing to determine their effectiveness, toxicity, and environmental impact. Prepare and test anti-FCI compounds to demonstrate that friendly forces can be protected from their effect. Based upon the results of FCI testing, propose a design concept for a FCI cruise missile payload.

PHASE III: Transition FCI weapon payload into land-attack/anti-ship cruise missile programs.

COMMERCIAL POTENTIAL: New methodology can be used by Law Enforcement and/or Customs Officials to preclude or halt the flight of criminal suspects using motorized vehicles or boats.

N96-060 TITLE: High-Temperature-Superconductor (HAS) Antenna Cooling

OBJECTIVE: Develop compact cooling apparatus for high-temperature-superconducting antennas that will not degrade antenna performance.

DESCRIPTION: The Navy is investigating several air-launched missile applications involving HAS materials operating below their superconducting transition temperature (~90-100 Kelvin). Designs are sought to actively cool antenna structures from ambient temperatures to well below transition temperature in short duration (on the order of 10 seconds), and maintain sub-transition temperatures for moderate times (on the order of 1-5 minutes). The structures are envisioned to consist of .020" LaA103 substrate material with dimension either (1) 6" diameter, or (2) .80" by .64". Multiple cooled rectangular antenna structures may be required per missile (possibly 36).

PHASE I: Develop hardware design to cool HAS antennas. Demonstrate through studies best cooling approach. Solutions must meet the functional needs of the HAS antenna system as well as requirements for affordability and producibility. Component testing to insure design capability is encouraged.

PHASE II: Pending the successful outcome of Phase I efforts, demonstrate operability of cooling apparatus in conjunction with sample HAS antenna system.

PHASE III: Produce cooling apparatuses for advanced development/testing efforts in preparation for transition to Navy ARM seeker/AIM seeker/data link applications.

COMMERCIAL POTENTIAL: The apparatus may be applicable to commercial HAS or electronics applications.

REFERENCES: MTSS 39(9), 1499-507

N96-061 TITLE: Development of CL-20 Based Explosive For Exploding Foil Initiators (EFI)

OBJECTIVE: Investigate CL-20 based explosive formulations in pellet form for use with EFI's which have a lower voltage threshold than current materials

DESCRIPTION: The production of exploding foil initiators (EFI's), which are the heart of Electronic Safety and Arming Devices (ESAD's) currently depends on the use of the explosive HNS-IV. There is a significant interest from all DOD services in finding a good replacement for HNS-IV. The output of HNS-IV is low, having a detonation pressure that is only 54% of the detonation pressure of PBXN-5. Because of this, EFI's must be made larger than desired, or an explosive with better output characteristics must be added to the output side of the detonator. HNS-IV is expensive, costing approximately $4000 per pound,

with procurement lead times of up to one year. HNS-IV is being produced by only one manufacturer (a DOE Facility), and that facility cannot manufacture material to meet the DOD specification. In addition, HNS-IV is recrystallized from HNS II, which is no longer manufactured in the United States.

PHASE I: Investigate the formulation of high surface area CL-20 powders and fabrication techniques for low cost pellets.

PHASE II: The second phase formulations using various binders with the best CL-20 power from Phase I a variety of EFI bridges will be investigated to determine the voltage threshold which EFIs will fire and producibility. Goal is to have a voltage threshold in the range of 600-700 volts.

PHASE III: In Phase III the explosive with binder and the bridge variant providing the most robust design will be qualified.

COMMERCIAL POTENTIAL: EFI's detonators are used in the commercial market for explosive operations. Applications for this technology include; use in adverse environments with high temperatures and potentially high electromagnetic fields that are capable of initiating hot wire detonations. The use of CL-20 in place of HNS-IV is attractive because of the reduced amount of hazardous waste produced - approximately 1/20 as much as HNS-IV.

N96-062 TITLE: Advanced IR Augmentation

OBJECTIVE: Develop innovative concepts in infrared (IR) augmentation technology to improve target IR presentations.

DESCRIPTION There have been a number of missile program updates to include and upgrade IR sensors. Evaluation of these systems has been deficient as there is no adequate IR augmentation source, usable on targets, that can fully exercise these sensors in the micron band in which they are designed to operate, at an intensity required to correctly exercise missile sensors. The newest seekers use imaging IR, therefore, there is a need to provide distributed IR sources that can exercise the discriminatory power of various image tracking methods.

PHASE I: Develop the concept for advanced IR augmentation in sufficient detail for a feasibility determination to be made, perform an analytical evaluation of the concept, and perform a simplified simulation analysis of the concept. This will include researching the characteristics of seekers now in use and those designs likely to appear in the near future.

PHASE II: Develop a prototype of the concept for advanced IR augmentation. Perform detailed analyses of its overall performance and of its performance with respect to the weapon system sensor. This analysis should be consistent with analyses of IR models used in all-digital and hardware-in-the-loop simulations.

PHASE III: Integrate onto selected target system identified in Phase II and test.

COMMERCIAL POTENTIAL: Infrared augmentation has potential applications within the heating industry. New IR augmentation has the potential to significantly reduce fuel cost.

N96-063 TITLE: Multi-Dimensional Solid Propellant Rocket Stability Prediction (MSSP)

OBJECTIVE: Improve current solid rocket motor stability prediction codes to include three dimensional acoustic flow fields, three dimensional grain design and ballistics and have the capability to predict the acoustic stability of both longitudinal and tangential acoustic modes.

DESCRIPTION: The Navy, Air Force, Army, and to some extent NASA, currently depend upon the Air Force funded Solid Propellant Rocket Motor Performance Computer Program (SPP) to evaluate the acoustic stability of solid rocket motors. Although the model has been updated in recent years to include improved grain design, ballistic performance prediction and nozzle design, the stability portions of the code are over 10 years old. Currently the stability prediction is limited to one-dimensional acoustics (longitudinal modes only) and is only coupled to the axi-symmetric and 2-D grain design. Recently numerous development rocket motors have experienced stability concerns which are outside the predictive capability of the current stability codes. It is proposed to increase the capability of the prediction code to include multi-dimensional acoustics coupled to axi-symmetric, 2-D and 3-D grain design and ballistics and to provide for both longitudinal and tangential stability prediction. In addition, current government funded efforts are underway in the university community to improve physical understanding and develop methodologies to better predict motor stability. These improvements will require the above stability code improvements in order to be incorporated into the next generation of stability prediction codes.

PHASE I: Perform a feasibility study for development of a standalone 3-D acoustic solid rocket motor cavity algorithm

which will be driven by the existing axi-symmetric, 2D and 3-D grain design and ballistic modules in the current SPP code. Couple the existing 3-D grain design and ballistics with the current longitudinal stability prediction module in the SPP program.

PHASE II: Implement the 3-D acoustic module into framework of existing multi-dimensional grain design and ballistics. Incorporate recent improvements to stability prediction such as distributed combustion, flow field effects and propellant response into the improved stability code.

PHASE III: Refine the code for commercial use including operational manuals, test cases, graphical interfaces and provide a variety of versions for different computer platforms.

COMMERCIAL POTENTIAL: The program will have wide spread use throughout the solid rocket motor community for both research and development and will be used in industry, government and university environments.

REFERENCES: "The Solid Propellant Rocket Motor Performance Prediction Computer Program (SPP), Version 6.0", G. R. Nickerson, D. E. Coates, A. L. Dang, S. S. Dunn, D. R. Berker, R. L. Hermsen and J. T. Lamberty, Air Force Astronautics Laboratory, AFAL-TR-87-078, December 1987.

N96-064 TITLE: Low Cost, Hot Gas Turbine Powered Hydraulic Power Supply

OBJECTIVE: Develop a hot gas turbine powered hydraulic power supply system

DESCRIPTION: Investigate and demonstrate the feasibility of using commercially available components such as automotive turbochargers and hydraulic pumps to produce a low cost, hot gas powered turbine driven hydraulic power supply and fuel pumping unit for tactical missiles.

PHASE I: Design a low cost, hot gas turbine powered hydraulic power supply and fuel pumping unit utilizing commercially available components such as automotive turbochargers, planetary gear trains, chain drives, and hydraulic pumps. The unit shall be capable of producing one (1) hp of hydraulic power and pump 0.5 Ibm/sec of jet fuel against a back pressure of 100 psia with a turbine air inlet temperature and pressure of 1200 ^{0}F and 20 psia, respectively, and an exit pressure of one (1) psia. The unit shall also be capable of supplying 5 hp of hydraulic power and pump 10 Ibm/sec of jet fuel against a back pressure of 500 psia with an air inlet pressure of 100 psia and an exit pressure of 14.7 psia. The unit shall be capable of sustaining the above operation for one hour. The contractor will also perform a production cost analysis of the unit.

PHASE II: The contractor will manufacture two complete units and test them to the specified conditions.

PHASE III: These power supply units will be used on an advanced supersonic missile system. The contractor will manufacture several of these units for flight demonstration tests.

COMMERCIAL POTENTIAL: These units could be used as hydraulic power supply systems on heavy equipment or as aircraft emergency hydraulic power supply systems.

N96-065 TITLE: Mini-Metrology System to Provide TROPO Inputs for GPS Error Reduction.

OBJECTIVE: Provide for the near-real time collection and application of atmospheric conditions to reduce the combined troposphere effects on location accuracy derived from GPS signal processing.

DESCRIPTION: Refraction of the GPS Carrier frequencies in a neutral atmosphere is independent of the particular application frequencies. The troposphere is non-dispersive with the refraction consisting of dry and wet components. The dry component contribution to range error at zenith is approximately 2.3 meters, based on an average atmospheric pressure. The zenith range error may be estimated from local surface pressure. The wet component contribution to error is dependent on the total signal path conditions. Model parameters effecting error resolution include: water vapor; temperature; altitude of players; and signal path elevation angle(s). For differential observation error correction application, the atmospheric conditions at the base-line ends, must be taken into account. The accuracy to which the water vapor can be determined along the line-of-sight will directly effect the ability to achieve centimeter level accuracy. The models to accept parameters which define atmospheric conditions and determine probable errors are available to refinement for variable signal path conditions. An on site (differential receiver) miniature meteorological station could provide current conditions for the computation of the dry and wet components. This would provide near-real time error correction.

PHASE I: Perform a feasibility study and develop a reasonable cost approach for providing the required atmospheric condition data to the model that is determining refraction error corrections.

PHASE II: Will result in the development, fabrication, and testing of an engineering development laboratory model, of the atmospheric conditions data collection and in-line computational processing, for the determination of error corrections and their application.

PHASE III: Build and document five prototype operational field units based on the results of the previous phase demonstration(s) and tests.

COMMERCIAL POTENTIAL: The system can be used for more precise location of FAA in-route air traffic and commercial airport final approach vectoring.

REFERENCE: Wells, Guide to GPS Positioning, Tropospheric Effects, Canadian GPS Associates, December 1986, May 1987.

N96-066 TITLE: Computer Code for Predicting Warhead Booster Performance

OBJECTIVE: Develop a computer code that can predict the performance of modern flyer plate boosters against insensitive main charge explosives.

DESCRIPTION: A convention warhead booster is a relatively shock sensitive small charge of explosive, easily detonated by the warhead firing train. The design of conventional boosters can be accomplished using modern reactive flow hydrocodes. To meet Insensitive Munitions requirements, modern explosives are often very shock insensitive. A promising concept for initiating shock insensitive main charge explosives uses an insensitive booster explosive to drive a flyer plate into the booster/main charge interface. This results in a very high pressure shock of short duration which produces a detonation in the main charge in a very short run distance. Analysis of the flyer plate booster with a conventional Eulerian reactive flow hydrocode. Shockwave Multimaterial Eulerian Reactive Flow (SMERF), shows that the detonation, once formed in the main charge, may then fail due to corner turning effects. These corner turning effects highlight the weaknesses of our current codes. Results obtained from these analyses were shown to be dependent on the computational mesh size, since the reaction zone of the detonation wave is very thin and it could not be resolved. The product of this SBIR would be a computer program that could be used for design and analysis of both conventional and flyer plate boosters. It would, therefore, be capable of simulating both the run up to detonation and detonation failure behavior of explosives.

PHASE I: Develop an approach for a computer code to design flyer plate boosters and validate the utility of that approach. A reactive flow hydrocode based on either CTH or SMERF, which the Navy currently uses, is preferable. Other codes will be considered, if significant advantages to the user community are demonstrated. If the approach, requires a burn model for the explosive, it must be calibrated from the results of small scale experiments. The calibration method for the burn model must be demonstrated. The overall goal is a code for use by the booster design engineer, that can be used to determine the properties of a good booster explosive.

PHASE II: Implement the approach developed in PHASE I. This includes writing or modifying the computer code, benchmarking the result against standard problems and verifying the performance of the computer code by experiments performed with insensitive explosives. The deliverables include the computer code and its technical and user documentation.

PHASE III: Transition of the developed computer code into existing analysis tools which will reduce and cost and development time of future ordnance systems.

COMMERCIAL POTENTIAL: A computer code of this nature has application in several commercial industries (i.e. petrolium, transportation, risk assessment, mining, and space). The ability to accurately predict potentially hazardous conditions and design systems in such a way to mitigate catastrographic failures, directly translates into savings in life, property, costs, and time.

REFERENCES:
(1) A Survey of Barrier MATERIALS for Mitigating Sympathetic Detonation, by E. Lundstrom, C. Carlton, and A. Thompson, published in the Proceedings of the 1993 JANNAF Propulsion Systems Hazards Subcommittee Meeting, Fort Lewis, WA, 10-14 May 1993.

(2) Naval Air Warfare Center Weapons Division. The SMERF Code-Multimaterial Eulerian Reactive Flow, by Larry Libersky, New Mexico Institute of Mining and Technology, Socorro, NM, and Eric Lundstrom, Naval Air Warfare Center Weapons Division, China Lake, CA., China Lake, CA., NAWCWPNS, September 1994. (NAWCWPNS TP 8206 publication UNCLASSIFIED)

(3) A Numerical Study of Fragment Impact on Bare Explosive", by Eric Lundstrum, Prodceedings of 24th ICT Conference, Karlsruhe, Germany, July 1993.

N96-067 TITLE: Separable Platform Glint/ Cross Polarization Target Signature Modeled RF Augmenter

OBJECTIVE: Provide realistic target signature features in an active wide bandwidth augmenter in a configuration that can move the aim point off the target platform.

DESCRIPTION: Target signature characteristics shall include glint, depolarization, fading, scintillation, phase reversals and jet engine/propeller modulation spectra. It is to be programmable and able to model the threat spectrum of airborne vehicles. The model will be accurate for a specified sector of the threat vehicle at the modeled aspect angle and for a region of test vehicle aspect angles for test purposes. The augmentation loop gain and amplification shall be able to simulate radar cross sections of 0.2 to 1000 square meters and remain stable when illumination power saturates the microwave chain. The JEM/PM, glint and cross-polarization modulations shall be undisturbed by saturation. The delays through the amplifier chain, cables, and modulators will be coincident with the geometric positions being modeled. Towed active sources will be used and "tuned" in time/frequency so the apparent position of the guidance target and the phase coincide. A towed web configuration shall be included. The augmenter shall be installable in the bulk of the tri-service targets. The augmenter will include a receive antenna, two to three transmit antennas, two modulation chains for glint and cross polarization, phase and amplitude modulation components, computer, memory and reeled tow antennas. The unit will augment over 2 to 18 GHz. It shall have preprogrammed -autonomous and grounded controlled target glint, depolarization, fade, scintillation and engine modulation.

PHASE I: Review existing SBIR programs for glint/cross polarization augmenters such as the multi-point augmenter, and the fading target generator for immediate use in the design. Review new technologies such as miniature towed modules and improved microwave/millimeter components. Design for installation in the BQM-74C and AQM-37C targets. Design to satisfy the stated objectives which have all been satisfied separately in other projects.

PHASE II: Design an augmenter with all the features specified under objectives for target installation in a BQM-74C with a two to three output horn installation. Design the installation to fit in the AQM-37C endure its worthy for its temperature and vibration environment. Build the augmenter and test it in the SPARROW or SM-2 hardware simulation to prove out the threat vehicle modeling and effect. Design the augmenter modulation control to be autonomous, uplink controlled based on ground track data or by use of miniature global positioning units. The augmenter program shall be entered by memory loader verifier (MLV) or equivalent, or selected by ground control. Install the augmenter in the BQM-74C or other missile target and flight test it. Develop and complete a threat vehicle signature data base for use in setting the augmenter characteristics.

PHASE III: Adapt the developed design to operate in at least 3 separate target models. Complete development and manufacture 6 units for first article testing in NAWCWPNS threat simulation targets. Perform simulation, captive and air launch evaluation of the augmenters. Perform operational use tests and provide operating manuals, programmer manuals and BIT description documents. Design an "end-to-end" microwave tester to prove out the glint and cross polarization modes.

COMMERCIAL POTENTIAL: Commercial air liner self protection against radar missile threats. Complex multi-directive radio beacon, control element in X- or K-band automatic landing system, complex electronic countermeasures, deployable/portable micro-wave repeater, repeater for surface obstructions in flyways, and repeater for race car telemetrics. Mineatureization and multiple modulation modes provides basis for desk top satelite communications, true PDA with satcom capability, wireless internet communications. Wireless PC for use at in stock exchanges as front end of client servers as Codic wireless protocal.

N96-068 TITLE: High Speed Scene Signal Processor Accurate Fuzzy Logic/Neural Network/Data Compressor High Speed Scene Signal Processor

OBJECTIVE: Apply Fuzzy logic, neural networks, and data compression technology to high speed (frame rate) precision scene processing for highly accurate target recognition and identification.

DESCRIPTION: The Navy currently uses high speed digital signal processors to process missile sensor and guided missile seeker scene information. Performance demands are increasing frame rates, pixel counts and constricting transmission bandwidth. Fuzzy logic and neural networks modeled to process IR or visual scene data rapidly and efficiently can be designed. Fuzzy logic and neural networks will be combined to provide scene noise filter, target detect, and target shape identification functions. These functions will be fully programmable so the scene signal processor can be employed with several types of detection schemes. Target characteristics action/guidance and response repertoire will be programmed in the fuzzy logic for alarm, response and guidance functions. The processor may be used for:

a. Identification Friend For at Beyond Visual Range
b. Replace current IR Visual Seeker Processing.
c. Combat Surveillance and Drug Enforcement and Interdiction:

PHASE I: Provide a survey and solution study to employ existing fuzzy logic and neural network knowledge using existing sensor technology. Design logic/ network for use with three types of detector arrangements (Rotating, Scanning and Staring focal plane array) and for stable and rotating field of view applications. Resulting processor shall reduce scene noise, detect targets in low Signal to noise conditions, identify targets and formulate alarm, responses and guidance signals. Frame rates from 60 to 1000 FPS and pixel arrays from 1 by up to 200 in line, 256 by 256 up to 1024 by 1024 arrays and 8 to 16 bit digitization will be accommodated. Programmable target feature and identification will be designed in to the processor. The processor must use low power and be reduced to fit with in aircraft and guided missiles. The design should be modular, open architecture to facilitate incorporation into a wide variety of sensors and platforms

PHASE II: Develop, test and operationally demonstrate the Fuzzy logic Neural Network, compressed data processor using existing seekers, or aircraft sensors. Demonstrate as well with at least 200 FPS and 256 by 256 pixel array with at least one commercial camera.

PHASE III: Produce the resulting compressed microelectronic processor or HMA package for use in a wide variety of commercial and military sensors as well as in existing guided missile and weapon control systems.

COMMERCIAL POTENTIAL: The new technology can be used in vehicle traffic monitoring, safety, and evidence recording. It may be used for security and surveillance for human and physical threat detection, evidence, alarm, and action/response.

REFERENCES: Neural Networks for Signal Processing, by Bart Kosko Prentice Hall pub. Neural Networks and Fuzzy Systems, by Bart Kosko, Prentice Hall pub.

NAVAL SEA SYSTEMS COMMAND

N96-069 TITLE: 3D Model Simplification for Simulation

OBJECTIVE: To develop software to automatically simplify CAD produced three dimensional models to a level of detail suitable for visualization and simulation.

DESCRIPTION: Computer Aided Design (CAD) systems are used to design complex machinery, such as ship systems. It would be advantageous to transfer the information available in the CAD system directly to a visualization and simulation computer system. However, the detail available in the CAD system is often much higher than the usable level of detail for visualization and simulation. The level of detail to be retained may also differ within a single model. For example, details of the inside of a model may be eliminated while many exterior details may be retained for realism. Software that would intelligently automate the process of reducing the level of detail with user control would accelerate the transfer process.

PHASE I: Develop the basic software for automatically simplifying CAD produced three dimensional models to models suitable for simulation and visualization. The basic code would be demonstrated on individual pieces of equipment such as pumps and control panels.

PHASE II: Develop, test, demonstrate, document and deliver operational software for larger CAD models such as entire ship/submarine compartments. This software would incorporate additional user control and would allow different levels of detail to be specified for different parts of the model.

PHASE III: Transition the operational software into an on-line documented production package. The software would be used for creating models to visualize and simulate systems aboard naval vessels and in other applications.

COMMERCIAL POTENTIAL: Many industries, such as the automotive and building industries, are using visualization and simulation. The software would have significant commercial potential by simplifying the process of transferring CAD models to visualization and simulation computer systems.

N96-070 TITLE: Integration of Specifications Information into a Product Model

OBJECTIVE: Develop the database structure and related software necessary to integrate specification information into the NAVSEA product model.

DESCRIPTION: Naval ship specifications have traditionally been produced as text documents. The complexity of the specification documents demanded that a designer have a working knowledge of its organization in order to find relevant information. Ship specifications are living documents that continually change and expand as the design progresses. With the

advent of computers, it became possible to move and maintain specification documents within the computer. Text search techniques improve accessibility, but a knowledge of the documents organization is still necessary to obtain information. The computer holds the text of the specification, but the specification is still fundamentally a text document. The organizational capabilities of the computer have not been exploited. Naval ship design at NAVSEA is moving into a computer-based product model environment. The product model utilizes a relational database to organize design data in ways that make it easier for the designer to access and update the data. With the advent of the product model, it has become practical to include the specification information in the database with the other design data. The specification information can be connected to the parts of the design that it affects in a manner that was never possible in the past. The details of the relationships between the specifications and the remaining design information is complex. Accessing and updating the specification information held in the product model demands new techniques that are different than traditional commercially available text retrieval methods.

PHASE I: Develop the basic software for accessing product model-based specification information. This will include the definition and implementation of extensions to the product model relational database structure. The basic software will access the extended product model to obtain specification information in a manner that indicates the feasibility of the technique to properly link information.

PHASE II: Develop, test, demonstrate and document operational software for accessing, updating and locally tailoring (ie. without destroying the master) specifications contained in a product model. This software will include the production user interface. Tests will be conducted to ensure that the software is suitable for use with the large volume of data present in a ship design and is capable of self linking to related areas of the product model in a dynamic manner.

PHASE III: Transition the operational software into a self documenting production package. The software would be used for accessing, updating and locally tailoring the specifications to assist with the ship design.

COMMERCIAL POTENTIAL: Many industries, such as the building industries, use specifications. The product model concept is increasing in popularity as a means of organizing engineering data. This unique software would have wide commercial potential by easing access to and providing control of specification information concurrently during design.

REFERENCES: Product Model Information is available from Computer Aided Engineering on the NAVSEA Headquarter's Internet server. The NAVSEA Internet home page address is http://www.navsea.navy.mil.

N96-071 TITLE: Object Oriented Data Base for Combat System Ship Design

OBJECTIVE: Develop an object-oriented database for Combat System Ship Design that integrates the Functions, Parameter, and Characteristics List (FPAC), Combat System Specification (CSS), Combat Compartment Location Arrangement Model (C/CLAM), Fiber-Optic Topology Design Tool (FOTDT), Combat System Catalog of Parameters for Equipments (C/SCAPE), Electromagnetic Assessment Workstation (EMA/WS), Ship Specification, and the CAD 2 Combat System Equipment Macro Libraries.

DESCRIPTION: The Navy currently uses many disjoined databases for Combat System Ship Design. The data-bases are at various security levels which has blocked previous attempts to integrate the information in them. The time and cost of developing Combat System Ship Designs for new construction and major overhauls are decreasing so that improved integration is required to meet Ship Design schedules and design budgets.

PHASE I: Develop the basic schema and design for an object oriented database that integrates the Functions, Parameter, and Characteristics List (FPAC), Combat System Specification (CSS), Combat Compartment Location Arrangement Model (C/CLAM), Fiber-Optic Topology Design Tool (FOTDT), Combat System Catalog of Parameters for Equipments (C/SCAPE), Electromagnetic Assessment Workstation (EMA/WS), Ship Specification, and the CAD 2 Combat System Equipment Macro Libraries. The design must be supported by NAVSEA CAD 2 equipment and software and the concept must be shown to be extensible to many other databases.

PHASE II: Develop, test, operationally demonstrate and document the design that was formulated under the Phase 1 SBIR effort. The design shall produce all the database related documentation that will support a Combat System Ship Design. The demonstration shall include a multi-level security system to permit classified and proprietary data to be stored in an approved inscription format with a security control access system to permit all classes of users only the access to the data that they have authority to access.

PHASE III: Produce a CAD 2 software product that implements the design demonstrated in the Phase 2 effort.

COMMERCIAL POTENTIAL: The new object-oriented database design could be used by commercial ship builders to support detail design of Navy and commercial ships. The commercial ship builders can input the need information for contractor

furnished information for the contractor furnished equipment in a integrated data environment to provide for an integrated data produce. This integrated data produce will then support computer logistic, computer aided detail ship design, and computer aided manufacturing.

N96-072 TITLE: Automated Human Systems Integration Tools for Reduced Ship Manning

OBJECTIVE: Develop and demonstrate automated tools to achieve effective, economical, and safe ship manning reductions.

DESCRIPTION: There is a strong impetus in Navy and commercial ship design to reduce the manning levels associated with the operation and maintenance of surface ships. This thrust is primarily motivated by a requirement to reduce operating costs. Costs associated with the human crew typically comprise 40 to 50% of a ship's operational and support costs. The constraints on reducing ship's manning include the potential impacts on: mission effectiveness, crew safety, crewman workload, and human performance capability. Historically, the most frequently applied method to reduce ship manning has been to automate tasks previously performed by a human, thereby reducing workload and manning requirements. This approach is not always effective due to an inadequate allocation of functions to human performance and automation, and to a failure to consider the most effective integration of the human in automated system operation. Human systems integration (HSI) application in early system design and development specifically addresses the allocation of functions issue, as well as the required roles of the human and automation, and the design of workstations, human-machine interfaces, jobs, procedures, and training systems to reduce human error, accidents, workloads, task complexity, and required skills for human performance in a reduced manning environment. The potential for reducing manning beyond the use of automation, through HSI techniques such as improved task simplification, decision aiding, and improved design for operability and maintainability, has been well demonstrated. The Naval Research Advisory Council, in a review of the status of man-machine technology in the Navy, estimated that the application of human-centered design methods in system design will result in a 20% reduction in required manning levels. What is needed now is to automate HSI methods and data which will result in effective and safe ship manning reductions. HSI methods and data include allocation of function techniques, design to reduce complexity and error/accident potential, modeling and simulation to assess workloads, support decision-making, and evaluate what-if conceptualizations of reduced manning impacts, and models of the affordability and risk associated with specific ship manning reduction approaches.

PHASE I: Develop a conceptual model of the activities accomplished by ship system design personnel in developing and implementing ship system and total ship design concepts for a reduced manning level. Define a ship reduced manning process which is integrated with each phase of the ship design process. Develop prototype tools to support the specific activities of the ship reduced manning process. Prepare technology development specifications for tools and models not currently available. Validate tools with ship scenarios, such as those associated with a reduced manning bridge.

PHASE II: Based on the technology development specifications developed in Phase I, further develop the methods, models, and simulation tools to meet the ship reduced manning tool requirements. Tools will be of three general types associated with the relevant phases of the ship reduced manning process. These tool types are: 1) analysis tools (allocation of function, comparability analysis, task analysis, tradeoff analysis); 2) simulation and prototyping tools (for workload assessment, manning estimation, and workstation design and arrangement); and 3) assessment tools for evaluation of the affordability and risk associated with a ship reduced manning concept.

PHASE III: Transition fully developed tools to assist in reduced manning efforts on future ship designs such as SC 21 and CVX.

COMMERCIAL POTENTIAL: The results of this effort will be applicable to any commercial application where there is a requirement to reduce manning levels, simulate the effects of these reductions on safety and performance effectiveness, and assess the impact of reduced manning concepts on affordability and risk. Examples of industrial applications include: commercial ships, process control systems, and transportation control systems (intelligent vehicle-highway systems, rail control systems, port control systems).

N96-073 TITLE: Robust Distributed Broadband Network Control System Development

OBJECTIVE: Develop a robust distributed broadband Asynchronous Transfer Mode (ATM) network system control, capable of supporting emerging broadband and wireless services in a robust, fault tolerant, and extensible manner.

DESCRIPTION: Network control provides for the effective functioning of network system transport. It is of central importance to the continued tactical effectiveness of an integrated ATM network, as well as to its cost effective deployment, to evaluate and

build this capability around existing and emerging industry broadband standards, capable of providing high bandwidth voice, data, and video services, for current and future military network applications. ATM is a connection oriented and packetized broadband network technology that allows users to transmit voice, video, data, and imagery over the same circuit. In addition to bandwidth requirements, it is necessary to establish a control architecture built upon robust networking systems providing for the automatic restoration, intelligent provisioning, and gathering of network traffic information. The objective of this research is to establish a distributed software package and associated network protocols capable of supporting current and future network control requirements. The proposed approach should pay special attention to ensuring the robust, verifiable, efficient, coordinated and real-time performance of network control software. The resulting system should be capable of easily being transitioned from a simulation domain into an operational domain with minimal re-coding effort. The system software modules should be easily maintainable, and extensible as additional system requirements emerge. System behavior should also be easily monitored, and capable of being operated in both an automated, and supervised man-in-the-loop mode.

PHASE I: Investigation of proposed concept. Develop a preliminary simulation of proposed solution, demonstrating feasibility of the network system service control layer. Include in the development features such as service control, Operation & Maintenance (O&M), and traffic management.

PHASE II: Demonstration of the proposed concept with a small scale lab based ATM prototype system. Prototype effectiveness will be evaluated, and scaling issues will be discussed.

PHASE III: Scaling of lab based system into a larger scale naval ship based application, such as the LPD-17's Shipwide Area Network (SWAN), or the CVN-76's Integrated Communications and Advanced Networks (ICAN).

COMMERCIAL POTENTIAL: This technology will have an impact in digital communication in the areas of network restoration, fault isolation, congestion control, and traffic monitoring, as well as in the development of distributed network control nodes.

REFERENCES:
1. ATM User-Network Interface Specification, Version 3.1, The ATM Forum, September 1994.
2. ATM Forum 94-0471R9, Private Network-Network Interface (PNNI) Draft Specification, Phase 1, June 16, 1995.
3. CVN-76 Presentation, Integrated Communications and Advanced Networks (ICAN), W. Page Glennie, CVN-76 Ship Design Manager
4. LPD-17 Draft Specification Section 409, Shipwide Area Network (SWAN).

N96-074 TITLE: High Power Multi-Layer Frequency Selective Filters

OBJECTIVE: Develop technologies and techniques for designing high-power, multi-layer frequency selective filters for the purpose of reducing the in-band and out-of-band radar cross section (RCS) of large shipboard antennas to aid EW effectiveness.

DESCRIPTION: Ship RCS must be reduced to make detection more difficult and to enhance the effectiveness of ECM and decoys. Areas other than vehicle top side structures contribute to the RF signature of ships, the main one being high-gain antenna systems. Reducing antenna RCS will make the on-board EW systems more effective.

PHASE I: (Concept Definition): Through the use of computer codes, develop passive band-pass and band-reject low loss multi-layer frequency selective surface (FSS) filters suitable for high power applications. Conduct high power analysis of multi-layer filters. Conduct a trade-off study to investigate filter power handling requirements and effectiveness in reducing RCS as a function of filter placement.

PHASE II: (Concept Demonstration): Develop candidate filters. Continue analysis into multi-layer FSS filters for high power applications. Perform high power tests on candidate filters.

PHASE III: (Concept Implementation): Transition a FSS to a government owned full scale antenna for further test and evaluation.

COMMERCIAL POTENTIAL: This technology has applicability in the private sector in the area of high power materials. In addition, other commercial benefits can be derived by utilizing this technology to reduce EMI crosstalk between nearby antennas.

N96-075 TITLE: Tools to Develop, Deliver and Exchange Electronic Technical Information in Support of New Research and Development (R&D) Projects

OBJECTIVE: Apply innovative tools and techniques to electronically develop, deliver and exchange design, engineering,

program management, product data and life cycle support information between Navy activities and the development contractor. This will reduce the cycle time and cost of preparing and distributing conventional products during the R&D phase and throughout the entire life cycle of the system.

DESCRIPTION: A broad range of expensive technical products related to R&D projects are currently developed and delivered to the fleet and shore support activities in paper and electronic forms. The products are typically developed and updated by assembling design, engineering and logistic information in stand-alone products such as technical manuals, parts lists, maintenance procedures and drawings; and distributing them to the requiring organizations. Tools and techniques developed under this topic should enable the raw technical information to be exchanged and delivered electronically using an integrated data environment without the cost and extended cycle time associated with repackaging in conventional products.

PHASE I: Design and implement prototype tools and techniques to enable electronic development and exchange of technical information for new R&D programs during system design, fleet introduction and life cycle support.

PHASE II: Determine requirements for implementation. Demonstrate using tailored commercially available tools and new techniques in a pilot project for an Advance Surface Machinery (ASM) R&D program. Document data requirements and data flows and technical package for use in all other R&D programs.

PHASE III: Extend and implement the tools and techniques on remaining ASM Programs in an integrated modular system that dynamically links between all the R&D projects as well as to other more administratively and production oriented systems. Create standard data requirements, tool sets, and data flows in order to extend the application to other Government R&D projects.

COMMERCIAL POTENTIAL: The tools and techniques can be used to develop, maintain and deliver up-to-date technical information to any complex commercial system such as power plants, manufacturing facilities, and chemical refineries.

REFERENCES: Navy/Marine Corps Manager's Desktop Guide for CALS Implementation

N96-076 TITLE: Facility for Radiative Susceptibility and Emission Testing

OBJECTIVE: Characterize the radiated susceptibility and emissions testing performance of an optimized hybrid transverse electromagnetic cell/reverberation chamber facility design

DESCRIPTION: Several hybrid facilities combining the features of transverse electromagnetic (TEM) cells and reverberation chambers (RC) have been constructed to demonstrate the feasibility of broad band frequency coverage in a single test facility isolated from the external electromagnetic environment. The performance of these proof-of-concept facilities has been positive. However, the available data is insufficient to characterize the overall facility performance for susceptibility and emissions testing versus design parameters including, for example, the linkage between uncertainty bounds in test results and test cost. These issues must be resolved before the concept can be employed as an accepted radiated susceptibility/emissions test facility.

PHASE I: Define the critical design parameters of a hybrid TEM/RC which impact field uniformity, frequency coverage, pulse response, test time, confidence in test results, and size scaleability. Develop theoretical models to address these issues and define experiments necessary to provide data on the performance tradeoffs as the critical design parameters are varied. Define the theoretical and experimental approach to correlating the test results from a hybrid TEM/RC facility to the results from existing facilities including but not limited to open area ground planes and MIL-STD-462 test procedures. Define the size scaleability of a hybrid TEM/RC facility.

PHASE II: Using a scale model or an existing facility, characterize the electromagnetic test environment over the required frequency regime as a function of the critical design parameters.

PHASE III: Develop a prototype hybrid TEM/RC facility with a validated software package for demonstrating facility performance and for conducting automated susceptibility and emissions testing.

COMMERCIAL POTENTIAL: All commercial electronic systems sold in the European Community will, effective in 2006, be required to pass stringent immunity tests in addition to the emissions test required in the US. It is likely that in response to the EC initiative, the FCC will extend its traditional emissions standards to include immunity standards as well. This will generate a demand for inexpensive facilities which provide low cost, high confidence, repeatable immunity and emissions testing and which can be correlated with currently specified regulatory test procedures. An optimized, single test facility such as a hybrid TEM/RC facility which meets the increasing commercial test requirements will have a significant impact on the cost effectiveness and time-to-market of the multi-billion dollar US electronics industry.

REFERENCES:
1) Crawford, M.L., Ma, M.T., Ladbury, J.M., and Riddle, B.F., Measurement and Evaluation of a TEM/Reverberating Chamber, NIST Technical Note 1342, Jul 1990.
2) MIL-STD-462

N96-077 TITLE: Shock Resistant Single-Mode Fiber Optic Connector

OBJECTIVE: Develop a shock-resistant single-mode fiber-optic connector/adapter that is compatible with the commercial ST type fiber-optic connector/adapter.

DESCRIPTION: The ST connector is the standard Navy single fiber connector (MIL-C-83522/16 and /17). Current Navy ST connectors/adapters configured with multimode fiber show transient losses less than 0.5 Db for a duration less than 50 microseconds during shock tests performed in accordance with the Navy standard shock test procedure, MIL-S-901. These same connectors/adapters show transient losses over 2 Db for a duration of up to 100 milliseconds during the same shock test when used with single-mode fibers. An improved ST connector/adapter is needed that will show transient losses less than 0.5 Db for a duration less than 50 microseconds during the Navy shock test. The improved ST connector/adapter must still be intermateable with standard ST connectors and adapters as defined in Electronics Industry Association/Telecommunication Industry Association 604-2.

PHASE I: Develop a design or designs for an improved single-mode ST connector/adapter that will show transient losses less than 0.5 Db for a duration less than 50 microseconds during standard Navy shock testing.

PHASE II: Build prototype connectors/adapters and perform standard Navy shock tests on the prototype connectors. Upon successful completion of prototype connector testing, develop full manufacturing capability and produce manufacturing representative connector/adapter samples. Test the manufacturing representative samples for compliance with the Navy fiber optic connector specifications.

PHASE III: Production and Sale of the connector/adapter to the U.S. Navy and commercial aircraft manufacturers.

COMMERCIAL POTENTIAL: The greatest potential for the improved ST connector/adapter is the commercial aircraft market. Aircraft vendors have not used typical commercial ST connectors because of concerns about the connector shock and vibration performance which this project will solve.

REFERENCES:
(1) EIA/TIA-604-2
(2) MIL-C-83522
(3) MIL-S-901.

N96-078 TITLE: Solid State Tritium Monitor

OBJECTIVE: Develop a reliable, portable, continuous processing, solid state detector which measures tritium levels in air to 1 microCurie per cubic meter (0.1 microCurie per cubic meter desired). The portable unit must be able to operate from standard 120 VAC power and weigh no more than 25 pounds.

DESCRIPTION: Develop a solid state tritium detector for shore and shipboard use. Present systems are bulky and measure only to about 5 microCuries per cubic meter and use ion chambers that require sensitive electronics which are susceptible to noise. A solid state detector will result in smaller monitors with higher sensitivity.
The new system should measure to 1.0 microCurie per cubic meter. (However, 0.1 microCurie per cubic meter is desired.) The system would be hardened against noise from power line and external gamma (Cobalt 60) fields up to 0.5 milliRoentgen/hr.. In addition, the unit must be compact and light enough (under 25 pounds) to be carried with one hand. Unit must be able to run continuously 24 hours per day with an average reliability rate greater than 2000 hours mean time between failures.

PHASE I: Design a reliable, streamlined, continuous processing tritium monitoring system. Provide experimental evidence that proposed design will meet sensitivity requirement. Provide report including experimental data. Demonstrate feasibility using laboratory setup.

PHASE II: Construct and provide prototype monitors for field test and evaluation. Conduct field testing with Navy potential users (to be determined). Provide report showing results of field tests, proposed design changes, and evaluation of technical difficulties.

PHASE III: Develop production model for Navy use. Conduct final field test and evaluation. This will be the transition to production phase.

COMMERCIAL POTENTIAL: This device will be useful to manufacturers of tritium devices (airport signs, tritium displays, watches) and commercial fusion power plants. The increased reliability will save wasted manpower in reacting to false alarms. The increased sensitivity will allow monitoring closer to environmental levels.

REFERENCES: Operational Requirement (OR) for Tritium Monitors (OR #182-04-89), [all performance-related excerpts to be provided to DTIC]

N96-079 TITLE: RF Voltage Measurement System

OBJECTIVE: A voltage measuring system is required which will be capable of measuring voltage from DC to 100 Mhz, from millivolt levels to 1,000 volts, at 10 ppm uncertainty or better.

DESCRIPTION: RF voltage measurements have traditionally been made using thermal converter techniques with standards such as the 1394/1395, TDO series, or the 540B. Thermal converter techniques are time consuming, subject to operator errors, and are not accurate enough to support new workload items while maintaining a four to one accuracy ratio. The new measurement system should be simple to operate, minimize interconnections, and provide an indication when it is being operated outside of its specifications. This device should be capable of serving as the Navy's highest accuracy RF voltage measuring standard for its maintenance level calibration facilities.

PHASE I: This phase will be utilized to develop a prototype RF Voltage Measurement System and to resolve any high-risk issues associated with the proposed approach.

PHASE II: This phase will be utilized to develop a prototype RF Voltage Measurement System and associated user's manual. Prototype system and user's manual should be suitable for utilization by Navy maintenance level calibration facilities.

PHASE III: This phase will be utilized to develop a commercial version of the RF Voltage Measurement System which would be purchased by System Command acquisition activities for use by maintenance level calibration facilities.

COMMERCIAL POTENTIAL: RF voltage measurement is a basic requirement of the electronics industry. A higher accuracy voltage measurement system which is easier and cheaper to use will be welcomed by the commercial market as well as by the military.

N96-080 TITLE: Computerized, Interactive, Generic Sub Systems vs. Total Ship System Design Program

OBJECTIVE: The objective of this topic is to develop a computerized, multi-platform, networkable, generic mechanical design program based on parametric modeling techniques using CAD and optimization software. The proposed initial use of this software is for Naval gun sub system designs with subsequent linking to total ship design modules.

DESCRIPTION: With recent developments in three dimensional Computer Aided Design (CAD) software, especially with the advent of parametric modeling and generalized optimization techniques, the opportunity has arisen to automate a significant portion of the current labor-intensive, costly, and time consuming efforts in mechanical design and integration of Naval Gun Sub systems. A short term goal of such a system development would be creation of an analysis tool that would allow systems engineers to develop a very quick system configuration for a proposed gun system to mount aboard a specific ship class. The long term goal would be to achieve a system with sufficient flexibility and accuracy to allow development of a complete gun design and subsequently other combat weapon sub systems through the use of a series of interlinked automated design modules. Such a system should be developed around a high level desktop computer system such as the Power PC or Pentium machines. The software should be icon driven with pull down menus. User friendliness is a must due to the wide range of personnel who would have use for such a system. The software should be developed in an open architecture, associative format (such as NAVSEA's SHIP Design Optimization Code (SHIPDOC), see references) to allow use on various machine types with easy access by follow-on modules as they are developed. Special emphasis shall be placed on integration of existing government sub system models and analysis tools into the system either directly or as peripheral modules. Output format should support dynamic simulation models that may be developed to evaluate gun weapon systems performance aboard ship.
This system would also allow commercial vendors of components and sub-components to develop interfaceable models of their components in somewhat of an electronic catalog/database of parts. The gun designer could readily incorporate these models

directly into the overall system with a minimum of effort. These models could be modifiable so that if an external feature of the component needed a change to interface with the system, the modified models could be directly fed back to the vendor for quote and/or procurement. This should be an advantage, not only to the Navy , but to the commercial suppliers also.

PHASE I: Explore the design methodology, input requirements, modeling and analysis techniques, and define the total scope of an effort to develop a parametric generic gun and weapon sub system design program.

PHASE II: Using the chosen design from Phase I develop, demonstrate and document a basic central processing model for a generic gun and weapon sub system design optimization both by itself and interacting optimally together with the shell of a total ship system design module.

PHASE III: Integrate this design into a self documenting production package with specific input models and specific parameter data to create the complete top level generic gun and weapon sub system design program. Develop interfaces to current Navy modeling programs for interior ballistic characterization, ship design, etc.

COMMERCIAL POTENTIAL: Development of such a program would open a large window of opportunity for many more interactive design programs with uses throughout commercial industries. Any type of design could be parametrically modeled with the correct input modules to produce the final item with a minimum of input data. These three dimensional models could be used in all areas of mechanical design and packaging throughout the military and commercial industries. This system would be the beginnings of a nationwide system of interlinking industries through networking which could eliminate many of the costly and time consuming mistakes and misunderstandings inherent in the long used two dimensional paper drawing system of communication. This system would be designed to be used with, but not totally eliminate the use of paper drawings and documentation. Such a generic system would have major impact on the automotive, aircraft, chemical, nuclear, oil and other industries. Since the system is based on CAD parametric modeling, it could be tailored to nearly any type of mechanical system.

REFERENCES:
(1) Ship Design Optimization Code (SHIPDOC), ASNE Proceedings 1983.
(2) SHIPDOC Status Overview of 19 Mar 1993.
(3) SHIPDOC Source Code (GFI).

N96-081 TITLE: Reclamation/Reuse of Pyrotechnic Ingredients

OBJECTIVE: Develop technology to reclaim valuable constituents contained in Navy pyrotechnic flares and smokes and develop/establish military and commercial markets for the reclaimed material. This project is for pyrotechnics materials - those designed to produce smoke and brilliant colors. These materials contain metals (e.g. magnesium, aluminum); metallic salts of copper, strontium, barium; oxidizer (e.g.sodium nitrate, potassium perchlorate); binders such as viton and dyes which have reclaimed value.

DESCRIPTION: The Navy has numerous pyrotechnic munitions which currently have no demilitarization capability. Many of these contain valuable resources which could be used in commercial applications. Previous work was limited to remediation and reclaim of energetic materials such as explosives and propellants (RDX, HMX, nitrocellulose, etc.) and is not applicable to pyrotechnic materials.

PHASE I: Conduct innovative research to develop technology(s) for recovering/reclaiming valuable ingredients (e.g. metals, oxidizers, binders) from Navy pyrotechnic flares and smoke munitions in an environmentally acceptable manner. Perform initial laboratory feasibility studies of most promising technologies.

PHASE II: Based on the Phase I most promising technology, develop the reclamation capability and document its capability by performing laboratory, bench, and pilot scale testing for reclamation and reuse of pyrotechnic ingredients from specific Navy munitions. Perform evaluations to validate recovered ingredients can meet specification requirements/performance criteria for reuse for either military or commercial applications. Demonstrate that the reclaimed pyro ingredients produced from the pilot scale plant provides the desired results under actual field conditions and that a market exists for the product. Perform complete systems safety and environmental evaluation to confirm no problem exists in the recovery and reuse of the various pyro ingredients.

PHASE III: Develop and test a prototype commercial facility for reclamation and use of pyrotechnic ingredients with the ultimate goal for contractor to establish a cost effective production facility.

COMMERCIAL POTENTIAL: Reclaimed pyro ingredients have commercial value and process has commercialization potential for pyro manufacturers.

REFERENCES:

NAVSEA/SW050-AC-ORD-010/NAVAIR 11-15-8 Publication "Ordnance Data for Toxic Hazards Associated with Pyrotechnic Items"

N96-082 TITLE: Low Cost Seeker (LCS) for Naval Surface Fire Support

OBJECTIVE: Develop a Low Cost Seeker for Naval Surface Fire Support Projectiles.

DESCRIPTION: This SBIR topic seeks to develop a LCS which will provide a terminal homing capability to the NAVY's long range munitions. While the primary mission of the LCS is naval surface fire support (NSFS), it is desirable that the LCS have residual capability in short range anti - air and short range anti - surface missions. Examples of these threats include low flying, high speed, maneuvering cruise missiles and small, agile surface craft. The LCS may function in any or all of the three operational modes: active, passive, or semi-active, however, all semi-active systems must be compatible with designator already in service with the US armed forces. Dual mode and/or multi-spectral systems arc of interest as well. If a dual mode system is proposed, it is desirable that at least one mode of operation be autonomous and as "all-weather" as possible.

The LCS shall be utilized on an airframe which will be inertially guided via a global positioning system (GPS) receiver and an internal measurement unit (IMU). The monition will autonomously guide itself onto the target area based on initial data loaded into the round either prior to launch or via uplink communications. The navigation and attitude control computer (NAC), on board the projectile, will activate the LCS and gather and process information from the projectile's IMU and LCS to implement terminal guidance toward the target. A two-way data path between the NAC and LCS should be assumed. It is highly desirable that the LCS be "strapped-down" to minimize complexity, cost and packaging volume and to maximize structural integrity. For design and analysis purposes. It may be assumed that the forward section of the projectile containing the LCS yaw, pitch and roll stabilized and that flight states and target positions are known by the NAC and may be used to stabilize seeker outputs and estimate range and time-to-go to target impact. All performance enhancing pre-processing of the guidance signal should be performed within the LCS itself. The terminal guidance algorithm (software) implemented by LCS shall be considered part of this development. Implementation of the terminal guidance algorithm shall be performed by the NAC.

The LCS shall include low-drag, optical elements and/or wave guides, signal processing electronics and software, exclusive of power source. The optical elements of the LCS shall fit within the external loci of a 3 caliber 80% secant ogive body of revolution thus minimizing the additional drag associated with the collecting aperture. As a minimum, The LCS shall be capable of providing the NAC with a measurement of the angle between a body off reference and the largest (error angle) at least every 0.2 seconds to an accuracy of 2.0 milliradians (or better) over the last kilometer before intercept. The LCS shall have a field of view of at least 10 degrees. It is highly desirable that the LCS output electronic signals proportional to the error angle over the entire field of view of the seeker. The field of view of the LCS may be biased at a fixed angle if necessary to enhanced performance. For design and analysis purposes, it may be assumed that the airframe is descending into the target area on a 20 degree glide slope at 300 m/s and can produce 1 G of lateral acceleration for every 5 degrees of airframe angle of attack.

The LCS shall occupy no more than the first 6.5 of the projectile nose length of a 3 caliber 80% secant ogive. In its tactical configuration, the LCS shall be capable of operating within specification for at least 30 seconds after activation by the NAC and after the application of at least 20,000 G's of set back acceleration in line with the be 3,000 and 10,000 G's, respectively. The unit production cost goal in quantities of 2,500 is $5,000.

PHASE I: Research and develop a preliminary design of an LCS, and report the theory of operation, estimated performance, technical risks.

PHASE II: The PHASE II program shall contain system design, hardware demonstrations, specified shock tests and technical reports which estimate, verify and document risk reducing demonstrations of the LCS and its components and will include hardware and software tests at 12,500 G of setback acceleration or higher,. It is highly desirable that this phase of development produce at least one deliverable unit of flight worthy hardware. The minimum hardware deliverable is a form, fit and function optics system with "brass board" electronics which can be "hardware-in-the-loop" tested by the Navy.

PHASE III: (A transition to a 3 year, engineering, manufacturing development (EMD) phase is anticipated which will be funded directly by the NSFS program office (PM 429). The EMD phase of the LCS development will be one element of a planned seeker/warhead Product Improvement Program (PIP) option to the ERGM. If PIP option is exercised, the LCS development shall be required to demonstrate form, fit and function hardware which shall perform as predicted and specified in the PHASE I/II studies. The seeker/warhead PIP test program shall include operational tests of the ERGM with LCS through the entire tactical gun launch environment, including the ammo handling system, as well as accuracy tests against a variety of target types.

COMMERCIAL POTENTIAL: The commercial application of this technology will be best suited for areas of development

which require high resolution, low cost imaging,. Some examples of such applications are aircraft, marine and land vehicle collision avoidance, robotics vision, automatic landing/recovery systems for high value research vehicles, all weather search and rescue and possibly industrial safety and security systems.

N96-083 TITLE: Modular Guidance Control Unit for Spin-Stabilized Projectiles

OBJECTIVE: Produce small electro-mechanical system (motors and generators) in a compact, highly integrated design. Apply this approach to a guidance control unit sub system for spin-stabilized projectiles fired from the 5"/54 MK 45 Naval Fire Support System.

DESCRIPTION: Current Computer Integrated Manufacturing techniques have great promise to produce highly integrated assemblies of motors, actuators, and generator, to replace the older design of individual machines assembled onto a heavy and bulky frame. The specific military application of this approach is to provide a control section for a guided projectile, which places the guidance and control elements (fins, actuators, electronics, antennas, and inertial components) in an aerodynamically despun section, using the despinning reaction to power the projectile. This approach permits the projectile to fly with a low-drag finless configuration at its initial high velocity, and allows a common component (a generator) to provide both electrical power and one axis of control. It also enhances the reliability of the projectile by allowing greater test-ability by eliminating one-shot devices, and by eliminating chemical batteries, which are reliability and demilitarization problems. This topic seeks a design for a such a guidance control unit. The guidance unit shall contain the fins, actuators, and motive power, to despin the guidance section and control the projectile's flight. Bank-to-turn (two-axis, pitch and roll) control is acceptable. Space and power allocations shall be made for guidance and navigation electronics, Global Positioning System receiver and antennas, uplink and downlink antennas, and terminal seeker. (The government will provide size, mass, form, and power needs). The design's actuators shall be powerful enough to drive fins that can produce a 3-G turning force at subsonic speeds (for long range, surface fire support) and 30 G's at Mach 3 for close-in defense against missiles.

PHASE I: Prepare a design and appropriate simulation models to establish its structural, mechanical and dynamic performance.

PHASE II: Construct a gun-launchable prototype of the PHASE I design.

PHASE III: The design would transition to the Naval Surface Fire Support program in production of a guided projectile.

COMMERCIAL POTENTIAL: In the specific design form needed for a guided projectile guidance unit, this device would also be suitable for a windmill generator producing 500 watts. In this size there is an immediate market for recreational sailboats, to provide power without running a gasoline generator. The design also scales up to larger generator outputs, suitable for specialized applications such as isolated electronic equipment such as microwave relay towers and cell telephone master sites, and for general power generation. Similar designs, incorporating multi-axis actuators in a compact hub, would be useful in ventilation blowers, variable-flow pumps for industrial plant equipment, and low-head hydroelectric generation.

N96-084 TITLE: Operational Training for FFG-7 Anti Air Warfare (AAW) Combat System

OBJECTIVE: To develop a shipboard operational trainer for the FFG-7 AAW combat system.

DESCRIPTION: Provide a means for training the FFG-7 AAW combat team to operate their equipment in condition 1 watch stations. The extent of training shall include the following equipments and/or functions: Fire Control System MK 92, air search radar AN/SPS 49, surface search radar AN/SPS 55, integrated sensor signal processor SYS 2, Tactical Action Officer, Air Detector Tracker controller, Weapons Control Officer, and Weapon Control Console operator. The training shall cover the entire combat process, from target detection to standard missile or gun engagement. The training is to be realistic and be based on a simplified tailored version of the philosophy being utilized for the AEGIS system Embedded Training Advanced Technology Demonstration program.

PHASE I: The contractor shall demonstrate the capability to develop an inexpensive FFG-7 operational trainer. The contractor shall provide cost estimates for the non-recurring engineering (less than $500,000) and the recurring cost for any Ordnance Alterations and/or Ship Alterations that may be required (unit cost less than $200,000). The cost for PHASE I shall not exceed $100,000. The contract will be firm fixed price.

PHASE II: The contractor shall build a prototype and demonstrate its capability through testing. During this phase the Government shall down select to 1 - 3 contractors. Costs for PHASE II shall not exceed $500,000. The contract will be

firm fixed price.

PHASE III: The contractor shall produce the first production unit, verify performance through application testing, and start production of up to fifty units. The contract will be firm fixed price.

COMMERCIAL POTENTIAL: The experience and technology gained from the development of a complex embedded trainer can be applied to the development of emmbedded trainers for complex industrial equipment such as very large scale chemical processing plant equipment or nuclear reactor plants.

REFERENCES: Embedded Training FY 96 ATD NAPD

N96-085 TITLE: Microwave Removal/Conversion of High Explosives from Loaded Munitions

OBJECTIVE: Develop microwave technology to remove/convert the high explosives from loaded munitions into a commercially usable product and establish a market for the materials.

DESCRIPTION: The Navy has numerous projectiles/munitions loaded with explosives such as Explosive D (ammonium picrate) which presents problems with demilitarization. Reclamation and separation/chemical conversion could provide materials which would have commercial value.

PHASE I: Determine which markets exist for the end use of the reclaimed material. Investigate microwave technologies to remove/convert the explosive in an environmentally acceptable manner. Perform initial laboratory feasibility studies of the most promising microwave technologies.

PHASE II: Perform laboratory, bench, and pilot scale testing of the microwave technology for removal/conversion of the explosive from loaded projectiles. Perform evaluations to validate removed/converted materials can meet specification requirements/performance criteria for reuse for commercial applications. Demonstrate that the reclaimed materials produced from the pilot scale plant provides the desired result under actual field conditions and that a market exists for the products. Perform complete system safety and environmental evaluations to confirm no problem exists in the removal/conversion of explosive and reuse of all materials.

PHASE III: Develop and test prototype commercial facility for reclamation and use of reclaimed materials with the ultimate goal for contractor to establish production facility.

COMMERCIAL POTENTIAL: Reclaimed materials have commercial value and process has commercialization potential.

REFERENCES: SW050-AG-ORD-010

N96-086 TITLE: Miniature Eye-Safe Laser Designator and Receiver

OBJECTIVE: Develop a small laser designator and matched receiver. The designator must operate at an eye-safe wavelength, and should be suitable for a small UAV or expendable aircraft. The receiver should be suitable for a five-inch, high g launched projectile. A more powerful version, suitable for mast mounting on a ship, is also desired.

DESCRIPTION: Military and commercial uses for laser range-finders and designators are limited by the need for an eye-safe wavelength. Current practice is to begin with a non-eye-safe Nd:YAG laser at 1.06 μm, and shift it with non-linear optics to an eye-safe wavelength, an approach that significantly limits the useful range. New materials, such as Erbium, are now making direct generation of eye-safe wavelengths possible. To provide naval gunfire against hard, mobile targets in areas where no forward observers are available, we need a small laser designator, suitable for use in an expendable air vehicle that is only 30 inches long. For the weapon (a five-inch guided projectile) we need a matching receiver. The receiver should be able to function in a spinning or non-spinning projectile. Both the air vehicle and the guided projectile must withstand gun launch forces, so mechanical designs that have no moving parts or very simple, robust mechanisms with reduced moving mass on are needed. Range needed is 3 km from designator to target and 2 km from target to projectile. Ability of the designator to operate as a range-finder is desirable. The illuminator should operate in the eye-safe wavelength such as 1.55 μm. The designator and receiver must support coding of the designation signal, to permit multiple designators to operate in the same area. Additional installation of the illuminator is possible onboard ship, where a range of 19 km designator to target and 2 km target to projectile is desired.

PHASE I: Develop a system design, and demonstrate a bench version of the source, optics, and receiver.

PHASE II: Produce a hardened, form and fit prototype for flight test and document design.

PHASE III: Production transition will be to the expendable air vehicle and guided projectile described above. Additional transition opportunities to larger UAVs are possible for a designator with a longer range.

COMMERCIAL POTENTIAL: The most direct commercial application is in range-finding for surveying and cartography. The added range available from a directly-generated eye-safe laser will permit measurements from aircraft or remote sites without the need to place retroreflectors on the surveyed points. Other laser tracker, laser range-finder, and laser illumination applications, such as laser radars used for aircraft flight research and laser inspection systems for road surface and elevated roadway inspection, would also benefit. Applications are also possible in point-to-point data links to moving vehicles, in metrology, and industrial process control using Raman spectroscopy. This topic itself leverages the commercial developments in erbium-doped fiber amplifiers developed for the telecommunications industry.

N96-087 TITLE: Composite 5"/70 Barrel Component for MK-45 Gun Upgrade

OBJECTIVE: The objective of this topic is to advance the state-of-the-art in composite materials in the areas high amplitude cyclic pressure fluctuations, and resistance to high temperatures (800 F) for use in development of a stretched 5"/70 caliber barrel for the MK45 gun that has basically the same moment and moment-of-inertia as the current 5"/54 caliber barrels.

DESCRIPTION: With the ongoing Naval Surface Fire Support (NSFS) Program, the need for an extended length barrel has become apparent. This comes from the goal of developing an upgrade to the 5" Mk45 gun that will produce muzzle energies in the 18-22MJ range. Increasing muzzle energy of the gun requires enhanced propulsion charges. This means more energetic propellant in larger volumes. A longer barrel is required to allow sufficient in-bore volume for complete combustion of the propellant and expansion of propellant gases to keep muzzle exit pressure within the allowable shipboard limit. The longer barrel also allows the pressure to act on the projectile for a longer time, thus producing a higher muzzle velocity (higher muzzle energy) even with the existing propulsion charges. The purpose of this SBIR is to investigate the use of high strength graphite composite material as an overwrap on a significant portion of a reduced thickness barrel near the muzzle will allow a 70 caliber barrel to be fabricated with similar weight, moment and moment-of-inertia characteristics to the current 54 caliber barrels. Such a barrel would eliminate the need for major modifications to the train and elevation drives of the Mk 45 gun system that would be necessary with a similar steel barrel. Thus, making the barrels interchangeable. Current commercial applications for pressure vessels deal largely with steady-state pressure systems which undergo only small pressure fluctuations, thus not bringing about the fatigue problems commonly present in gun barrels. These vessels are used for low temperature operation only, due to degradation of the epoxy binder at high temperatures. The goal of this effort is to develop composite materials, fabrication methods and design methodology that produce a pressure vessel that can withstand both the fatigue loading and the high temperatures present in gun barrel applications.

PHASE I: Explore the design methodology, materials requirements, manufacturing requirements, and required verification test series necessary for development of a 70 caliber composite overwrapped barrel for use with the Mk 45 system. The barrel must withstand the proposed muzzle energy upgrades, and yet be compatible with the current ammunition and firing rates. Special attention must be given to the thermal loading resulting from sustained firing through a single barrel. The results of this phase should be a barrel design with a corresponding development test program.

PHASE II: Using the chosen design from PHASE I a barrel will be developed.

PHASE III: Complete engineering development of the barrel, producing a commercially manufacturable unit that has been integrated into an upgraded MK 45 gun system.

COMMERCIAL POTENTIAL: The largest commercial potential for this technology would exist in the chemical, nuclear, automotive, and aircraft industries. Commercial uses of this technology would exist in high temperature fluid flow and collection apparatus, especially portable systems that require light weight components. With both high temperature capabilities and high resistance to fatigue, these materials could play a major role in development in lighter, more efficient automotive and aircraft engine components. Suspension and drive train components would also be prime candidates for this technology.

N96-088 TITLE: Inertially Guided Micro-machined Navigating Device with Application to Submunitions

OBJECTIVE: Capitalize on the coming large-scale availability of micro-machined accelerometers to develop inertially-navigating devices that can increase their accuracy by calibrating themselves against the Global Positioning System or other more accurate sources. The specific military application will be an inertially-guided submunition that can be carried in a larger, GPS/inertial

guided airframe. The submunition will align its own low-quality INS to the carrier's GPS/INS, so that when released, it will guide itself to its aimpoint.

DESCRIPTION: Micro-machined inertial components (accelerometers and gyroscopes) are projected to be available in large quantities at very low cost, due to the demand from the automotive industry. Detroit will be using these sensors primarily as rate sensors: for example, to measure deceleration for air bag deployment or turn rate for active skid control. But these sensors can also be used in a military-style inertial navigator, provided they can be accurately calibrated and initialized. Such navigators can then be used for military and commercial navigation applications, and would be particularly useful where other more accurate navigation is sporadically available. In the military application, this situation occurs when a GPS guided projectile encounters jamming, or when a submuntion is released from a carrier vehicle. In the commercial sector, GPS becomes unreliable in cities, in the canyons between tall buildings, because of multipath, and under heavy tree cover.
The Naval Surface Fire Support (NSFS) program is developing gun projectiles and missiles that will use the Global Positioning System (GPS) and inertial navigation for its guidance. If a submunition were equipped with a low cost inertial navigator based on automotive-grade micro-machined inertial technology, and a comparably low cost control system, it could align its navigator the high quality GPS/INS of the carrier vehicle, and when released, fly for a limited time with enough accuracy to hit 80 percent of the targets in the NSFS target set. Such an Inertially Guided Submunition must operate to meet the following specifications: Submunitions must survive a 30,000 G gun launch from a 5"/54 gun to 63 nautical miles. The submunition will be released up to one minute before target impact. On release it will be able to divert 2 kilometers from its ballistic impact point, and have sufficient additional control authority to compensate for environmental effects such as wind. Required accuracy is 3-15 meters (taking the carrier's GPS/INS as truth). Submunitions will be dispensed at Mach 0.8 or below, either individually or in clusters, with each submunition individually and separately targeted. Payload is not to exceed 0.5 kilogram. The primary objective is to produce a low cost submunition design with a simple control mechanism.

PHASE I: Develop a design approach and concept which best meets the goals of performance and cost. Demonstrate in a simulation the resulting accuracy.

PHASE II: Fabricate a brass-board Inertially Guided Micro-machined Navigating Device submunition and document its design. Perform ground and flight tests to verify its performance. Demonstrate gun-launch survivability in an air gun.

PHASE III: Convert the Inertially Guided Micro-machined Navigating Device submunitions brass-board design to a producible form. Transition would be to the Naval Surface Fire Support program, with additional possibilities in strike warfare.

COMMERCIAL POTENTIAL: Low cost miniature inertial sensors, the primary sensor to be developed under this activity, have extensive potential commercial application in measuring and controlling manufacturing processes, general aviation, robotics, industrial automation, medical electronics, sport fitness equipment, personal computer mice, virtual reality, and toys. Integration of commercial inertial measuring components with military-derived navigation methods will provide navigation and position-recording capabilities for automobiles, surveyors, hikers, outdoor workers, and equipment, even when GPS and other external navigation sources are not continuously available. One specific application illustrates this demand: Hikers and other outdoor workers are currently buying GPS navigators in large numbers, but still must carry magnetic compasses because GPS does not have a gyroscope or compass capability. However, the GPS position history can be used to calibrate an inertial navigator that would provide compass, horizon, and vertical measurements, with the added benefit that these measurements would not be affected by the deviation and variation errors of a magnetic compass. The low-cost inertially-guided submunition itself would be applicable to commercial low-velocity projectiles, such as line-throwing guns for sea rescue, tear gas canisters, and non-lethal law-enforcement equipment. (Because of their low velocity, these devices are currently very inaccurate.) Note that the navigation capability is itself dual-use (both military and commercial applications for the navigator), and combines spin-on (use of commercial-grade micro-machined devices from the automobile industry and the underlying commercial silicon production base) with spin-off (use of inertial sensors for navigation, plus the ARPA investment in micro-machining technology).

REFERENCES:
1. Elwell, John, "Micromechanical Inertial Instruments for Commercial and Military Application", 50th Annual Meeting, Institute of Navigation, June 1994
2. Elwell, John; Publicover Joseph, "Silicon Instrument Technology-Strategic Applications" (Secret), AIAA Missile Sciences Conference, Nov 1994

N96-089 TITLE: Oscillator Stabilization In Shock And Vibration Environments

OBJECTIVE: To design and develop a Stabile Master Oscillator (STAMO) which can perform without degradation in the adverse shipboard environment of shock and vibration.

DESCRIPTION: Several existing and proposed radar systems are limited in performance by oscillator noise side bands created by the shock & vibration environments (e.g., gunfire, engine vibration, g-forces, missile launches, road shock, etc). Improved STAMO's are needed for use in Radar and Communication equipment that will perform without degradation in severe shipboard environmental conditions.

PHASE I: Evaluate design concepts for the improved STAMO. These concepts may include unique resonator designs, special mechanical mountings and/or feedback to the oscillator circuit from environmental sensors. Shall address the critical technical issues.

PHASE II: Develop several models of the STAMO and test under various conditions of shock and vibration.

PHASE III: The STAMO design shall be matured for production.

COMMERCIAL POTENTIAL: Stable oscillators are required in many radars, communication, telemetry and measurement systems. In military systems, severe environmental conditions are expected. However, with the explosion of commercial mobile communications and more sophisticated commercial telemetry, the need for precise performance in hostile vibration environments has increased dramatically. Development of a good technique could make many new applications feasible.

REFERENCES: V. A. Rosati and R. L. Filler, Reduction of the Effects of Vibration on SC-Cut Quartz Crystal Oscillators, Proc. 35th Annual Symp. on Frequency Control, pp 117-121, 1981.

N96-090 TITLE: Signal-to-Noise Ratio Meter

OBJECTIVE: Develop a signal-to-noise ratio (SNR) meter for use in microwave component development and advanced radar systems design.

DESCRIPTION: The Navy solicits proposals to facilitate the incorporation of microwave SNR measurements in the design of active radar systems. The successful applicant shall develop an economical meter which displays the total signal-to-noise ratio (SNR) of pulsed and continuous microwave signals and/or the degradation of the SNR caused by microwave components. The meter shall measure the compensated Moving Target Indicator (MTI) and pulse doppler performance of pulsed radars. The design of the meter should meet the following requirements: 1) Accuracy (±0.1 Db); 2) Resolution (±0.01 Db); 3) Measurement time (1 second (maximum)); and 4) SNR range (90 to 160 dBc/Hz minimum).

PHASE I: Shall develop and evaluate several design concepts for the proposed meter. The designs shall address the technical and operational tradeoffs, including the following requirements: 1) SNR dynamic range maximization; 2) r.f. noise bandwidth range; 3) separation of AM and PM noise; 4) correlation of AM and PM noise, 5) noise spectra (AM, PM and total); and 6) spectral aliasing. The analysis and design shall be in sufficient detail to indicate a good probability of success under PHASE II. An optimized design to be tested in PHASE II shall be fully described in a final report.

PHASE II: Should provide a high-quality versatile SNR meter for an on-going NAVSEA program. A prototype of the SNR meter shall be fabricated, tested, demonstrated and evaluated. Test results shall be compared with those obtained by existing conventional techniques for accuracy and speed of response.

PHASE III: The design shall be matured for production. Full development for commercial, military and university research applications is envisioned. Target commercial industries include communications, aerospace and remote sensing industries.

COMMERCIAL POTENTIAL: Strong commercial potential exists. The continuous monitoring of SNR in microwave components can be utilized for many applications (design, production and repair) in both military and commercial applications. The meter will enable microwave engineers to improve the quality of their designs and to produce lower noise components. The meter will also enable continuous monitoring of the stability of these microwave components and alert the operator if corrective action is required.

REFERENCES: Goldman, Stanley, "Phase Noise Analysis in Radar Systems," 1989, John Wiley & Sons.

N96-091 TITLE: Nanosecond Opto-electrical Switches

OBJECTIVE: To design, demonstrate and develop reliable electrically-controlled opto-electrical switches suited for fiber optic microwave delay line applications.

DESCRIPTION: Opto-electrical switches are needed for time delay beam-steering for future wide-band active radar systems. Current photonic beam-steering applications are limited by large insertion losses and poor switch performance, either with respect to cross-talk or switching speed. Configurations to be considered include: Single Pole Single Throw (SPST), Single Pole Double Throw (SPDT), and Double Pole Double Throw (DPDT). The following technical objectives are needed in an opto-electrical switch:

(a) low insertion loss / polarization sensitivity
(b) high optical extinction (greater than 40 Db)
(c) nanosecond switching times
(d) operation at 1310 nm and 1550 nm wavelengths
(e) small size and light weight
(f) low switching voltages
(g) potential intergradation with other devices, such as electro-optic modulators and wide-band photodetectors
(h) stable characteristics over a wide temperature range
(i) stable characteristics over long operating times
(j) low cost

PHASE I: Conduct and document a comprehensive survey of the state-of-the-art technology in electrically controlled electro-optic, magneto-optic and acousto-optic switching. Based on the results of this investigation, the contractor shall provide one or several design options which address the technical objectives in an opto-electrical switch. A hardware demonstration would be desirable.

PHASE II: Selected switch(es) shall be manufactured, tested, demonstrated and delivered for a NAVSEA fiber optic delay line. Test results shall be compared with state-of-the-art technology.

PHASE III: Full development for commercial, military and university research applications is envisioned. Target commercial industries include communications, aerospace, and optical monitoring and remote sensing industries.

COMMERCIAL POTENTIAL: Opto-electrical switches are widely used in analog and digital fiber optic communications and data links, sensor arrays, fiber gyroscopes and optical computing applications. In addition, there are potential markets for photonic radar beam-steering and delay-line technology in the civilian aerospace and telecommunications industries.

REFERENCES:
1) Henry Zmuda, and Edward N. Toughlian, *Photonic Aspects of Modern Radar*, (Artech House, Inc., Norwood MA 1994) chapters 13, 17; 2) John E. Midwinter, *Photonics in Switching* (Academic Press, Boston 1993); 3) Robert G. Hunsperger, *Integrated Optics: Theory and Technology* (Springer-Verlag, New York 1991).

N96-092 TITLE: <u>NTDS Archival Tool Using RAID Technology</u>

OBJECTIVE: Develop a system using Random Array Independent Disks (RAID) hardware and software that replaces low performance/storage capacity NTDS peripherals with higher performance, flexible archive workstation systems. One archive workstation will replace between 8 and 16 NTDS peripherals , such as RD-358 or USH-26. Additionally, the archive workstation will provide access to commercial support management (HSM) software, which will migrate collected data from disk to tape based on a user-specified migration policy.

DESCRIPTION: The archival tool will allow all communications between NTDS computer systems to be captured by a high performance microcomputer workstation, such as a Pentium or SPARC based system. Interfacing hardware is currently available using off-the-shelf NTDS cards for all NTDS interface types, serial and parallel. The archive workstation will assemble the captured data in a near-line high capacity RAID disk and, via the HSM software, will migrate it to tape as needed. A simple TCP-IP network will be established to allow commercial support computers to access the collected data. The HSM will move data from tape to disk, as required by support computer requests, to make the collected data appear as one consistent virtual file system.

PHASE I: Study requirements and methods for developing a system to meet the above objective and description. This will involve analyzing system configurations and performance requirements. Performance specifications for tape and disk drives, NTDS interfaces, and the archive workstations will be identified. Data acquisition, storage and migration will be determined. NTDS communication requirements will be measured. An archive workstation prototype will be demonstrated which contains 2 NTDS interfaces, a small near-line disk, a commercial tape device and the HSM software.

PHASE II: Continue archive workstation development needed to archive data for one or two complete AEGIS

elements, i.e. C&D and WCS. A sophisticated tape storage handling system, using one or more robotic changers, will be added to the PHASE I system. In addition, higher performance network connections, such as HiPPi or FDDI, will be used for communication with commercial workstations.

PHASE III: Expand into multiple AEGIS elements and additional support computers. Prepare land-based development, testing, training and integration sites for installation of complete archive workstation.

COMMERCIAL POTENTIAL: Other systems could be developed that collect data from other interfaces or networks. For example, the NTDS interfaces could be replaced with MIL-STD-1553 or ethernet interfaces. Almost any market that includes computer technology would benefit from the use of archival technology. The ability to store large amounts of data and to have that data on-line for retrieval would be a great benefit and in some case, a necessity, to systems used in these markets.

N96-093 TITLE: Standard Forth Generation Language for Interface Specification and Simulation

OBJECTIVE: The objective of this topic is to develop a fourth generation language (4GL) which can describe and simulate software protocols over military and commercial communications channels. The 4GL will automate the design and specification of a software protocol including the message structure, syntax and operational sequence for both "sides" of the interface. Once a software protocol has been specified, the tool can simulate either "side" of the interface using commercial hardware interface cards. Such a tool allows more complete specification of interfaces, more thorough analysis of existing interfaces and a powerful development tool for assessing impact of baseline upgrades and modifications.

DESCRIPTION: Demands increase every day for new hardware interfaces needed to implement new data communication requirements. It is becoming increasingly cost and time prohibitive to purchase specialized simulation equipment whose sole function is to exercise one interface. Because of the growth in the data communication technology, in software and hardware areas, more powerful tools are needed to specify, design, test and simulate new software protocols as improved hardware/communication technology becomes available. This need is further justified after systems specification and development, during life-cycle maintenance and field support, where interface problems account for an increasingly large percent of installation and operational problems.

PHASE I: Determine techniques for specifying software protocol in terms of messages, message content, data validation, and sequential exchange of messages. This level of effort should provide a prototype to define the interface specification language, as well as define a standard operating procedure.

PHASE II: Using the design from PHASE I, develop a working interface using existing hardware and software interface requirements specifications for one AEGIS and one commercial interface which requires complex data simulation logic.

PHASE III: Fully implement the project into a commercially existing application and demonstrate its ease of use.

COMMERCIAL POTENTIAL: The commercial market potential for this product is unlimited, as demonstrated by the large number of emulator, testers and analyzers currently available and presently being developed. Additionally, any time a need arises to integrate two pieces of hardware with a communications channel, data will have to be formatted in order to test the hardware. High speed data collection systems gathering external source data will have the need for this interface.

N96-094TITLE: MCM Dynamic Planning Tool

OBJECTIVE: To develop a computational tool that provides near real-time estimates of a minefield's penetrability and casualty production potential. Used as a component of CSS's tactical expert system, this tool will allow the user to dynamically manage minesweeping operations.

DESCRIPTION: Minefields are a major obstacle to naval operations in littoral waters. There is great need for a capability of dynamically planning mine countermeasure operations that are designed to minimize the effect of minefields on missions such as amphibious assault, etc. A crucial component in meeting this need is a dynamic planning tool that incorporates updates in intelligence, surveillance, reconnaissance data as they become available, to produce a near real-time quantification of the effects on penetrability and casualty production of a specified set of minesweepers in operation for specified amounts of time; and the relationship among the risk of casualties, minesweeping assets committed, and time allocated for minesweeping. This tool must accommodate the operational characteristics of hostile mines, including such features as sensitivity, ship-counter, and arming-delay settings. It must be suitable for execution on a high-end desktop computer (such as a pentium-based pc).

PHASE I: Develop, describe, and illustrate the architecture of the dynamic planning tool. Documentation is to include

textual/block diagrammatic descriptions of the analytical approaches taken in problem formulation and definition (formulated in cooperation with CSS) of two fully functional demonstration modules ('limited scope" / 'full scope') that can serve as prototypical examples for proof of concept.

PHASE II: Develop a prototypical dynamic planning tool that implements the architecture specified in PHASE I in the form of a program that executes on the aforementioned high-end desktop computer. Within, respectively, one year/two years after PHASE II commences the 'limited scope'/'full scope' demonstration modules defined in PHASE I are to be fully functional. Deliverables are: (i) a technical report that updates and expands the documentation given in PHASE I by interrelating system variables and parameters; (ii) all procedures and algorithms are to be provided in a form appropriate for immediate encoding into a target language by a CSS programmer experienced in the target language; (iii) a user's guide that includes a symbol dictionary defining all input and output variables, program constants and parameters, source listings of all programs, and sufficient test case data for verification purposes.

PHASE III: Expand the scope of the planning tool so that it can be used in the dynamic planning of sea mine clearance operations in support of an amphibious assault. The tool is to be placed in a form so that it can immediately be transitioned, as a fully functioning component, into CSS's tactical expert system analysis tool for MCM systems. Complete documentation with algorithms and procedures is to be of the same form as that described in the PHASE II.

COMMERCIAL POTENTIAL: The analytical approaches and computational procedures developed for formulating and solving the nonlinear optimization problems associated with this particular application should be applicable to a variety of other applications not limited to the software development industry.

N96-095 TITLE: Real-Time Pixel Array Processing Architecture (PAPA)

OBJECTIVE: Develop and fabricate a real-time image processing architecture. The architecture must be capable of handling high-speed military applications, using sensor arrays of 512 x 512 or greater.

DESCRIPTION: Mine reconnaissance using an autonomous underwater vehicle (AUV) requires extremely powerful computing capability. Presently, much of the data gathered in the field must be processed off-line. Typically, the images obtained are of 512 x 512, or lower resolution, and many image processing algorithms operate on smaller submatrices of the image. Use of either a parallel processor architecture or an array of optimized, dedicated pixel operation units (POUs) might provide the necessary computing power to allow the required real-time processing capabilities.

PHASE I: Propose a design to meet the requirements based on available technology. An order of magnitude estimation of the computing requirement is that if the calculations were to be performed by a single processor, that processor would need to perform tens to hundreds of GFLOPS (billions of floating point operations per second).

PHASE II: Implement the design proposed in PHASE I. Fabricate, package, and test the prototype design. Upon successful completion of testing, evaluate the design for incorporation into a specified weapon with regard to the required parameters. Required specifications will be supplied by the Magic Lantern Program at NSWC/DD/CSS.

PHASE III: Fabricate and package preproduction samples suitable for field testing in both military and target applications. This product will transition into the Magic Lantern, and Mine Reconnaissance Programs.

COMMERCIAL POTENTIAL: The PAPA has application in manufacturing process control using machine vision, quality control using automated visual inspection, medical imaging, automated guidance systems, and automatic target recognition where many images must be processed and/or computation-intensive image processing algorithms must be performed in a short time.

REFERENCES: "Annual Proceedings Of The International Conference On Pattern Recognition" available through DTIC.

N96-096 TITLE: Wide Dynamic Range Absolute Pressure Sensor

OBJECTIVE: A pressure sensor is sought which uses micromachining technology for oceanographic research for Naval mines. The particular effort is to develop an absolute pressure sensor to avoid the costs of a liquid backfill. The physical and electrical interfaces must match existing Navy underwater data collection systems. The sensor must be environmentally rugged.

DESCRIPTION: Measurement of small amplitude pressure changes in deep water typically requires a differential technique using a liquid backfill to counter the high static pressure. The hydraulic low pass filter subsystem of the sensor is typically bulky and expensive to produce. Additionally, silicone oil in backfilled sensors is susceptible to voids below -40 degrees F, reducing

storage and delivery options. Micromachined silicon pressure transducers offer the capability to detect low frequency (0.5 to 250 millihertz), absolute pressure changes of 0.05 inches peak-to-peak in water to 600 ft depths. To measure acoustic signals (2 to 500 Hz), 120 Db dynamic range is required. Sensor and electronics fit within a cylinder of approx. 2 inches diameter and length. Power consumption is limited to 2 mW from a 5 to 7.2 VDC supply. Thermal gradient error for a water temperature ramp of 5 degrees F over 20 minutes must not exceed 0.2 inches water pressure. The sensor must survive shock, vibration and temperature environments.

PHASE I: The vendor shall prepare a report demonstrating the feasibility of a micromachined absolute pressure sensor to meet Navy needs. Micromachined transducers elements and electronic interface circuitry shall be fabricated to demonstrate the proposed concept by pressure tests in the laboratory.

PHASE II: The vendor shall design and fabricate twelve (12) absolute pressure sensors suitable in form, fit, and function for response and environmental testing in the lab and at sea. The sensors are for evaluation in NAVSEA- and ONR-sponsored R&D programs.

PHASE III: The sensor, upon meeting Navy requirements, will be transitioned into the NAVSEA-sponsored mine improvement program. The final design shall be produced in quantity for full evaluation for production and use in Naval mine programs.

COMMERCIAL POTENTIAL: High quality, mass producible absolute pressure sensors can be used in numerous industrial applications: e.g., oil tank seepage detectors, tank fill depth sensors, barometers, altimeters, tsunami detectors, tide gauges. This sensor may make possible many other academic and industrial applications.

REFERENCES:
1) Bryzek, J., K. Peterson, and W. McCulley, "Micromachines on the March," IEEE Spectrum, May 1994, pp. 20-31.
2) Gabrielson, T., "Mechanical-Thermal Noise in Micromachined Acoustic-Vibration Sensors," IEEE Transactions on Electronic Devices, Vol. 40, No. 5, May 1993, pp. 903-909.

N96-097 TITLE: VMEbus Supportability/Test Software Tools

OBJECTIVE: The objective of this project is to research and develop innovative methods that are independent of specific users and vendors to address life cycle support issues associated with VME architectures. The intent of this objective is to potentially develop universal VMEbus test software tools to assist DoD users with VME Bus testability Life Cycle support problem.

DESCRIPTION: The use of VMEbus circuit cards integrated into VMEbus based architecture systems is now widespread throughout DoD. As the utilization of VMEbus based systems becomes more widespread, there exists the potential for proliferation and duplication of on-line/off-line test software to provide VMEbus supportability. Although most test and diagnostic software requirements for VMEbus systems are strictly application specific for each user and vendor, VMEbus interface logic and open system architecture are well defined with common standards. The solution presented in this project is to research and determine standard VMEbus interface logic and commonality that are independent of specific users and vendors. If sufficient standards and commonality are identified and quantified, the intent is to develop VMEbus test software tools that can be used universally regardless of unique system application. By developing universal VMEbus test software tools and making them generic enough to cross system boundaries, potential duplication of VMEbus test software within DoD can be avoided.

PHASE I: Explore VMEbus architecture and interface logic standards to identify, define and quantify common parameters that are independent of specific users and vendors, and determine the feasibility to develop VMEbus-test software tools to test VMEbus circuit cards in a VME chassis in multi-user multiple configurations. Study DoD utilization of VMEbus architecture systems to determine most commonly used VME circuit card technologies (e.g. DSP, Serial I/O, Memory). Recommend tests for each specific VME circuit card technology which are independent of specific vendors. Provide analysis of VMEbus supportability benefits that may result from development of universal VMEbus-test software tools. Provide analysis of application of universal VMEbus-test software within DoD to determine if potential duplication of effort can be minimized.

PHASE II: Develop VMEbus-test software tools that specifically address the common and standard VMEbus parameters defined in PHASE I. Procure a VME chassis to use as VME test bed and identify, for Government selection, specific VMEbus circuit card technologies that are the best and the worst candidates to be tested. Design and develop user-tailorable (to meet application specific requirements) VMEbus-test software tools, for the Government-selected candidates, to support VMEbus circuit card technologies in multi-user defined VME chassis configurations. Apply and demonstrate VMEbus-test software tools for the selected VMEbus prime system. Provide an Economic Analysis (EA) in the use of universal VMEbus-test software tools in conjunction with application specific test software development versus traditional VMEbus test software

development. Report shall be submitted 6 months after award.

PHASE III: Utilizing the VMEbus-test software tools developed under PHASE II, build and integrate VMEbus software into on-line/off-line software diagnostics of designated VMEbus Navy systems. Incorporate VMEbus test software as part of the prime systems Performance Monitoring/Fault Localization (PMFL) and self-test capability. Manufacture a VMEbus chassis test bed to support testing of VMEbus circuit cards. Build VMEbus chassis test bed software utilizing the tools developed under PHASE II. Construct VMEbus chassis test bed and software to support multiple user and multiple VMEbus system configurations. Establish a Navy-wide VMEbus supportability program. Setup infrastructure to provide test software support for VMEbus based systems. Disseminate VMEbus test software and VMEbus supportability information to firms with potential commercial applications of Navy VMEbus-test software tools. Establish Navy nomenclature to Navy wide VMEbus-test software tools. Provide life cycle support and maintenance of such software. Provide VMEbus-test software tool to all Navy Programs acquiring VMEbus systems. Provide VMEbus chassis test beds and software to meet end-user requirements.

COMMERCIAL POTENTIAL: VMEbus architecture is an industry standard and is used throughout commercial industry. Potential applications include widespread use and potential further development by private industry.

N96-098 TITLE: Enhanced Air Quality Management

OBJECTIVE: Ozone based air cleaning for removal of chemical and biological contamination.

DESCRIPTION: Current technology in ozone/air and ozone/water based cleaning and decontamination of air streams can be applied in Naval applications for controlled atmospheres to protect personnel and mission capabilities in theaters subject to threat of chemical and biological (C&B) warfare. Additionally, this technology has medical applications in the treatment of forces returning to the ship after exposure to viral or bacterial agents that must be isolated from ships general population.

PHASE I: Establish the feasibility of applying ozone based cleaning for air quality management (AQM) for human health and mission sustaining requirements. The study will result in identification of user environmental requirements. Define an AQM system which utilizes ozone as a means to react with chemical and biological agents in the air stream that could degrade mission capability by adversely affecting human resources.

PHASE II: Develop a preliminary design capable of processing ships airflow to result in adequate cleanliness with reference to C&B agents. Develop a demonstration plan for the adaptation of ozone treatment for AQM.

PHASE III: Fabricate, test, and validate an AQM system for submarine and shipboard use which utilizes ozone based treatment based upon the preliminary design completed in PHASE II.

COMMERCIAL POTENTIAL: Potential commercial applications include medical and hospital industries. These facilities are typically large buildings with controlled air which is partially recycled, requiring treatment to prevent spread of chemical or biological contamination. Medical facilities in general, will house a population with high sensitivity to airborne viruses.

N96-099 TITLE: Reverse Osmosis (RO) Systems Applications

OBJECTIVE: Develop innovative RO System component designs.

DESCRIPTION: The existing submarine RO design utilizes two positive displacement pumps. The first pump is used to pump 18.0 gpm seawater up to 900 psig. The second pass pump pumps 5.0 gpm freshwater up to the same pressure. Each pump measures 23 inches long and 18 inches high. The current pumps are plunger-type, positive displacement and require multiple desurgers to dampen the pulsations down to the point where the RO unit will meet the structure-borne and fluid-borne noise requirements for NSSN. Essential to the operation of the RO unit is the need to maintain a fixed flow (within plus or minus 3%) at the RO brine outlet. The existing submarine RO unit design accommodates this by dumping the brine to a tank (0 psig backpressure), from where it is then pumped overboard using a separate system. To reduce the dependency on other systems, and to reduce the volume and weight occupied by the RO unit and its associated systems, a Quiet Brine Throttle Valve (QBTV) is highly desired.

PHASE I: Based on identified technology, define the component designs and required system interfaces to meet desired performance. Develop technical, cost and schedule estimates and associated risks.

PHASE II: Perform detailed design of innovative RO components. Fabricate and demonstrate components to adapt to current submarine(s) system hardware.

PHASE III: Fully integrate the successfully demonstrated RO component technologies. Liaison with SBIR POC for

land-based verification and validation and eventual at-sea testing.

COMMERCIAL POTENTIAL: Application to the design and development of new marine vehicle fresh water production system for oceanography research, cruise ship tour industry, and the merchant ship industry.

N96-100 TITLE: Database driven 3D Compartment Arrangements

OBJECTIVE: Provide an automated 3D CAD arrangement tool for submarine compartmentation.

DESCRIPTION: The system will automate the manual compartment arrangement process embedding intelligence (historical data, design standards, and constraints) in the 3D CAD modeler. Current technology mainly involves CAD systems as modelers only; the design process involving data and constraints is done off-line. The system and process would be geared toward a networked multi-user environment.

PHASE I: Establish the feasibility of developing an automated 3D CAD arrangement tool for application to submarine compartmentation design. The study will result in identification of CAD and database technologies, 3D CAD performance parameters and functional requirement at a minimum.

PHASE II: Develop a preliminary 3D CAD submarine compartmentation arrangement tool design and demonstration and validation plan. Develop a prototype system using the technologies identified in PHASE I and test to the approved demonstration and validation plan.

PHASE III: Integrate the successfully demonstrated arrangement tool with other design tool technologies at a designated government facility. Incorporate historical data and existing standards requirements and demonstrate as a complete system.

COMMERCIAL POTENTIAL: Creating an intelligent CAD arrangement system would be widely applicable, e.g. building construction, commercial shipbuilding, and vehicle design. The target of this task is compartment modeling for submarines, but it would apply to any process involving automated compartment arrangements.

REFERENCES: NAVSEA 3D Product Modeling Guidelines

N96-101 TITLE: Fuel Cell for Replacement of Submarine/ Battery Diesel Generator Emergency Power

OBJECTIVE: The objective of this topic is to replace the current submarine battery/diesel generator emergency power with fuel cells capable of increased energy density, low noise, and reduced recharging time.

DESCRIPTION: There are 126 nominal 2-volt cell lead-acid batteries currently used for emergency power in submarines. The current optimum lead-acid battery design delivers 1,500 kw for a one hour rate. The batteries have a 10 year life for 400 cycles. The volume occupied is roughly 1,000 ft^3, with a weight of about 100 tons. The lead-acid batteries possess high weight and volume characteristics that limit submarines with respect to size and maneuvering capabilities. Fuel cells have shown dramatic improvement in storage capacity over current batteries. Fuel cell stacks may be assembled to provide the desired dc bus voltage required to operate the submarine emergency power. Fuel cells are advantageous in terms of size, weight, performance, reliability, maintainability, efficiency and noise.

PHASE I: Develop a optimized fuel cell stack design (operable from Navy logistic-system fuel) and a proposed prototype fuel cell stack configuration based on available fuel cell technology.

PHASE II: Using the proposed design, fabricate and develop a prototype fuel cell configuration and perform validation testing at a recognized testing laboratory for fuel cells.

PHASE III: Transition the technology to the acquisition sponsor upon the successful completion of PHASE II.

COMMERCIAL POTENTIAL: Many commercial applications are suitable for fuel cells, ranging from mobile electrically powered vehicles to any stationary power generation application.

N96-102 TITLE: Active Vibration and Acoustic Control

OBJECTIVE: Identify active systems for the control of the vibration of a geometrically-complex surface and to define, document and demonstrate design practices for an integrated surface material/transducer.

DESCRIPTION: Traditionally, the control of noise and vibration has been achieved by a combination of hydrodynamic design (to minimize the forcing function) and the use of passive vibration control. The passive control includes tailoring of material damping, geometric shaping, and the addition of mass. Further gains using passive techniques may need to be supplemented with other methods to meet the future requirements of marine vehicles. Active vibration control is such a method that has been demonstrated in selected cases to have the potential for significant improvement in surface vibration control. It is desired to generalize the application of active vibration control. The objective of this effort is to demonstrate the design of a submerged system capable of creating at least a single order of magnitude increase in surface normal displacement over a 50-2000 Hz band width. This will require the development and demonstration of high power density actuators, sensing devices and a control approach. It will also require the development of fabrication procedures to permit the incorporation of the components into a surface structure. It is important that the transducer installation not compromise the structural integrity of the surface. The design practice used to define the system must be clearly documented to permit the design of other surface, material, and transducer arrangements.

PHASE I: Based on identified technology define a practice to design, fabricate and evaluate the actuators and sensors required to provide the desired performance. Also define the hardware and software required to control the method.

PHASE II: Demonstrate and document the design practice necessary for the definition and fabrication of a transducer/surface arrangement. Design and fabricate a system for evaluation in a controlled flow environment. Validate the design practice and demonstrate the performance of the control system, and its limits of performance.

PHASE III: Integrate the successfully demonstrated component technology with other vehicle performance technologies by designing and demonstrating a noise and vibration control system.

COMMERCIAL POTENTIAL: Application to the vibration control of marine vehicles for oceanography research and commercial shipping, aircraft and land-based vehicle cabin noise control, and industrial machinery vibration control.

N96-103 TITLE: Materials Research In Sliding Electric Contacts

OBJECTIVE: Improve the performance and decrease the material constraints, complexity and cost posed by the present state of the art metal fiber brushes.

DESCRIPTION: The sub-component that generally limits the power and torque density of direct current motors and generators is the sliding electric contact usually called a brush. These brushes are required to transport the armature current over a range of speed and current densities while providing minimum power loss and maximum wear life. Unfortunately, techniques and parameter adjustments which tend to minimize power losses, also tend to increase wear and vice versa. In conventional direct current machines the brushes must switch current across commutator bars. This current switching can lead to arcing which causes increased wear and general degradation of brush and machine performance.

Great strides have been made in developing metal fiber brushes for non-switching slip ring technology. The research effort described herein will explore and develop innovative materials and fabrication techniques which can be used to satisfy the requirements of a commutating metal fiber brush.

PHASE I: Develop innovative materials and fabrication techniques for fiber brushes in direct current machines. A report will indicate applied pressures, types of innovative materials, potential mechanical loads, frictional losses, brush wear and potential slip ring applications at high speed and high current densities.

PHASE II: Demonstrate the technologies identified in PHASE I. Define and document the fabrication techniques required to produce the brush technologies. Demonstrate the brush technologies and establish their potential operational capabilities.

PHASE III: Integrate the successfully demonstrated brush technology and fabrication techniques, fabricate an operational system and verify the performance

COMMERCIAL POTENTIAL: High performance brushes are an enabling technology for any advanced direct current electric machine. Principle applications include machinery which require high torque and loads which require high current. High torque electric motors are used in shredding machines, paper mills and punch press drive systems. Potential transportation systems include conventional electric trains, electric cars and magnetically levitated trains. Compact, high performance DC generators

will have applications in the electroplating industry and pulsed electric welding sources such as used in offshore drilling industry. High current, low voltage dc electric machines will provide the most efficient, reliable method of utilizing environmentally attractive alternate low voltage energy sources such as derived from solar, thermoelectric or fuel cell technology. Low power applications also exist such as high quality instrumentation slip rings used for strain gauge or temperature measurement on rotating equipment.

REFERENCES:

D. Kuhlmann-Wilsdorf and D. Alley, "Commutation with Metal Fiber Brushes", in Electrical Contacts 1988, see also IEEE Trans. CHMT Vol. 12, pp. 246-253, 1989.

N96-104 TITLE: Dynamic Control of Undersea Vehicles

OBJECTIVE: To develop a computational approach that describes the effects of advanced propulsor and appendages to control the motion of an undersea vehicles. To demonstrate the use of this approach in the design of a propulsor-appendage arrangement to provide a specified vehicle motion.

DESCRIPTION: Scale model experiments are performed to address a wide variety of problems related to the design of the appendages and propulsor that influence the control of the dynamic motion of undersea vehicles. The results of Captive Model (CM) and Radio Control Model (RCM) experiments are conducted to obtain data that are used in computer simulations to develop the submerged operating envelope (SOE), recommend ship control recovery procedures for selected casualties, and define ship control trainers. The consideration of advanced propulsor concepts (multiple propellers, pumpjets, etc.) and advanced control forces producers (multiple lifting surfaces, thrust vectoring, thrusters, force augmentation, etc.) indicate a significant, and as-yet, highly unpredictable effect on the vehicle motion. The ability to predict the non-propulsive forces generated by different propulsor and control force producing arrangements, including the effects on the ship in four-quadrant operation, is needed. There is also a need to be able to define new means for providing vehicle control forces.

PHASE I: Establish the feasibility of developing an analytical physics-based approach to predicting the effects of advanced propulsor concepts and control force producing arrangements on the stability, maneuverability and control of submerged platforms. This will result in the identification of realistic technical, cost and schedule factors associated with military and commercial applications; determining an approach using empirical, then semi-empirical and finally analytically based prediction capabilities to be pursued; and the identification of scale model experiments, predictive model development and validation/certification of predictive efforts.

PHASE II: Develop an analysis practice and demonstrate the component technologies identified in PHASE I and judged to provide a practical solution. Define and document the integrated design/analysis practice required to apply the component technologies.

PHASE III: Integrate the successfully demonstrated component technologies, fabricate an operational system, and verify the integrated performance.

COMMERCIAL POTENTIAL: Application to the design and development of new marine vehicles for oceanography research, commercial shipping and recreation boating.

N96-105 TITLE: Depth Keeping Digital Algorithm for Control of Undersea Vehicles in Shallow Water

OBJECTIVE: To develop an innovative design digital "hovering" algorithm to integrate with existing undersea vehicle equipment and components to permit depth keeping in an littoral environment.

DESCRIPTION: The U.S. Navy Submarine Force has greatly increased their operations in littoral environments [1]. Currently, Navy submersibles including submarines and experimental platforms are being backfitted with a modified hovering control system using antiquated SSBN 640 Class analog components. There is an urgent need to upgrade these assets with state-of-the-art digital control which exhibits the following characteristics:

1. Capable of being used on various appendage hullforms.
2. Capable of accurate digital modelling of secondary wave equations and directional wave probabilities in a 'brown water' environment. Perform necessary wave studies to verify and validate controller performance.
3. Capable of accepting various weights to be added to the various hullform(s).
4. Capable of adapting to current hullform system hardware configurations with minimal alterations.

5. Capable of applying artificial intelligence to improve system performance.

PHASE I: Review existing digital controllers and algorithms. Propose new design approaches for digital algorithms to meet required performance characteristics for depth control. Develop technical, cost and schedule estimates with associated risks.

PHASE II: Develop digital code which correctly models the shallow water secondary wave equations and predicts directional wave probabilities. Fabricate or procure and modify a digital controller to adapt to current submersible(s) system hardware and incorporate and execute the digital hovering algorithm. Demonstrate controller and algorithm.

PHASE III: Fully integrate the successfully demonstrated controller technologies. Liaison with SBIR POC for land-based verification and validation. Conduct Full scale at-sea testing.

COMMERCIAL POTENTIAL: Application to the design and development of new marine vehicle control systems for oceanography research.

REFERENCES: "From the Sea"

N96-106 TITLE: Submarine Electrical Hull Penetrators/Connectors

OBJECTIVE: Develop electrical hull penetrators/connectors that will provide reliable transfer of electrical power through the pressure hull of submarines to externally mounted electrical devices.

DESCRIPTION: Increased use of electrical power on submarines requires the ability to locate electrical components such as actuators, propulsion motors, and auxiliary units outside the pressure hull. This requires the development of a range of electrical hull penetrators/connectors to transfer electrical power through the pressure hull. Requirements are for both 3 phase ac as well as dc power. Voltages to 5,000 volts and currents to 100,000 amps are being considered. Power requirements will range from actuator levels to main propulsion levels.

PHASE I: Review existing penetrator designs. Propose new design approaches for both high current low voltage and for low current high voltage applications. Document the work in a report to be delivered at the end of phase I.

PHASE II: Select candidate approaches based on phase I work. Design and fabricate prototype penetrators/connectors. Test the prototypes in a pressurized sea water environment at full rated current and voltage. Develop design approaches for full scale applications. Provide a preliminary design for the prototypes at the end of the design phase. At the end of PHASE II deliver the prototypes, a test and evaluation report, and the preliminary designs for the full scale penetrators to be developed in phase III.

PHASE III: Based on the results of the phase I and II work, design and fabricate full scale penetrators/connectors. Test the penetrators/connectors in a pressurized sea water environment at full rated current and voltage. Provide a detailed design report and drawings for the penetrators/connectors at the end of the design phase. At the end of phase III deliver the final penetrators/connectors and a test and evaluation report, and produce penetrators/connectors to meet Navy installation requirements to be identified.

COMMERCIAL POTENTIAL: Electrical penetrators/connectors are applied to deep submersibles and undersea oil exploration and production. They are also applicable to underseas power generation, and pressure vessels.

N96-107 TITLE: Micro Electro-Mechanical Systems (MEMS) for Shock Physics

OBJECTIVE: Improve the capability to measure the response of submerged and partially submerged structures to underwater shock.

DESCRIPTION: Underwater explosions have long been characterized only in terms of their shock waves for purposes of assessing damage to structures in the water. Although the great damage potential of the "bubble" of gaseous explosive products has long been recognized as a source of significant target damage, lower frequency bubble effects were "designed away" by using stiff structures that tended not to respond to the relatively low frequency excitations imposed by the bubble.
Recent developments in computer technology have resulted in development of highly efficient numerical procedures which permit accurate theoretical predictions of the motion of the water surrounding an underwater explosion; give approximate descriptions of the interaction between the responding structure and the water, and describe the response of the structure. The mathematical models developed using these modern computerized numerical procedures are difficult to create and always require experimental

validation prior to use in ship design. Recent ship designs have relied heavily on mathematical models which have identified vulnerabilities to low frequency bubble loadings and bulk cavitation closure loadings. Experimental validation is essential. Instrumentation currently used in underwater explosion response experiments was originally designed fifty years ago for of producing high frequency data associated with the shock wave of an underwater explosion. Recent innovative modifications to accommodate late time, low frequency responses of both the free field and the structure continue to fall short in some category, e.g a gage that moves with the fluid.

PHASE I: Establish the feasibility of using Micro Electro-Mechanical Sensors (MEMS) for data acquisition of underwater shock events. The report should identify realistic technical, cost and schedule factors associated with military and commercial applications, determining test instrumentation capabilities, identifying upgrades to test instrumentation for validation of physics-based codes and recommendations for further studies.

PHASE II: Develop a preliminary design of and demonstration plan for a MEMS. Perform demonstration/proof of principle subsystem tests to establish sensor sensitivity with respect to measurement capability and resistance against shock and accelerations, power consumption and type of source and frequency response and duration of response.

PHASE III: Integrate the successfully demonstrated MEMS subsystem technology, fabricate a full scale operational system and verify its performance.

COMMERCIAL POTENTIAL: There are many possible uses for the technology developed under this SBIR Topic. Some potential applications include: (1) diving & salvage, (2) rescue teams (i.e. fire fighters, divers, Search And Rescue, etc.), and (3) seismic event data acquisition. In addition, there are benefits in transferring this technology to ecological and recreational sources.

N96-108 TITLE: Permanent Magnet Motor Systems

OBJECTIVE: Design and construct affordable Permanent Magnetic variable speed (PMVSD) motors/drives for auxiliary applications in US Navy submarines.

DESCRIPTION: Permanent Magnet (PM) variable speed drive (VSD) motors promise favorable ship impact if they can be substituted for hydraulic systems and actuators in US Navy ships. Other uses include Heating, Ventilation and Air Conditioning (HVAC) and a whole range of small motor applications. Although PM motors are currently more expensive than induction motors of the same horsepower, they may offer improved efficiency, especially in applications which require large motor air gaps (e.g. flooded motors). This effort will investigate solutions to the affordability problem and construct several PM VSD systems to verify the results.

PHASE I: Estimate and report the impact of PM VSD systems in auxiliary applications in US Navy submarines. The following should be considered in the study: (1) level of current and future technology in the area of PM materials and power conditioners, (2) impact of standardization of equipment and systems simplification, (3) reduction of piece part count, (4) impact on fuel efficiency of the ship, (5) impact on maintenance and operational flexibility, (6) impact on military effectiveness metrics such as quieting and survivability, (7) impact on component, module and ship size/weight, (8) impact on ship producibility, and (9) impact on US industrial base. Design to cost targets, a desirable range of applications and preliminary design detail should be established and reported.

PHASE II: Design several PM VSDs, having an expected favorable impact on auxiliary systems, from the resultfo the PHASE I study.

PHASE III: Construct prototype PM VSD for submarine qualification.

COMMERCIAL POTENTIAL: While phase I will quantify the effect on the US industrial base, PM VSD systems will be used in commercial applications such as HVAC systems in large buildings.

N96-109 TITLE: Fire-Fighting Alternatives

OBJECTIVE: To develop effective, cost efficient, and non-toxic alternatives to existing fire-fighting systems on U.S. Navy surface ships and submarines

DESCRIPTION: U.S. Navy submarines and surface ships currently deploy a variety of fire-fighting alternatives, such as halon, seawater, and foam systems. New and improved alternatives are being explored for reasons such as:

- enhanced fire-fighting effectiveness,

- environmental concerns (e.g., CFC dispersion),
- reduced installation and maintenance costs,
- reliability,
- ease and safety of application, and
- volume requirements

Certain techniques, non-toxic gas systems, may take advantage of existing dispersion systems, thus reducing installation costs on existing vehicles. Candidate fire-fighting alternatives must demonstrate improvement over existing fire-fighting systems with respect to fire-fighting capability and other criteria as listed above. New nozzle and dispersion systems may overcome certain limitations of existing systems. Dispersion of non-toxic, ozone-safe gases (such as Lyumer-E) is an alternative, with potential benefits in terms of effectiveness, environmental concerns, system maintenance, and safety. Systems may involve either new development or technology transfer from existing applications in the United States or abroad.

PHASE I: Evaluate, quantify and develop candidate technologies for application in surface and subsurface vehicle fire-fighting systems. Document expected improvements over existing systems in terms of fire-fighting capability, safety, toxicity, anticipated installation and maintenance costs, system reliability, and compatibility with existing dispersion systems. Identify further test and analysis requirements. Conduct additional testing to verify the effectiveness of the proposed methods.

PHASE II: Create and demonstrate test prototype system for shipboard applications. Obtain Environmental Protection Agency (EPA) certification incident to transferring the technology to the United States. Develop and test prototype non-toxic gas and/or water-mist fire-fighting systems for shipboard applications.

PHASE III: Fabricate, validate and test candidate fire-fighting systems for submarines and surface ships, which utilize the results of the previous phases of this SBIR. Obtain any Environmental Protection Agency (EPA) certification necessary for sales for commercial ship, aircraft, and industrial applications.

COMMERCIAL POTENTIAL: Any military or commercial fire-fighting application. Potential customers include commercial ships (e.g., cruise ships, cargo ships, ferries), chemical and petroleum industries, airlines, and firefighting stations.

N96-110 TITLE: Flow Noise Reduction Techniques to Enhance Underwater Sonar Performance

OBJECTIVE: Demonstrate techniques which reduce the effect of flow noise on the performance of sonar on underwater vehicles and weapons, and which permit effective operation at higher speeds.

DESCRIPTION: Sonar performance on undersea vehicles and weapons can be significantly degraded by turbulent pressure and shear fluctuations generated on the surface during underwater motion. Such fluctuations may be interpreted by the sonar as acoustic noise which masks actual acoustic signatures. This problem generally intensifies at higher vehicle speeds, with implications for both submarine stealth and vulnerability and also for underwater weapon maximum speed. It is desired to identify and exploit practical new techniques which will reduce the impact of pressure and shear fluctuations on sonar effectiveness, particularly for high-speed motion. It is desired to have the potential to actively tune the method applied for different operating conditions, according to optimization criteria which shall be developed as part of this effort. Techniques which may be considered include, but are not limited to, artificial cavitation, polymer ejection, and liquid jets. Some of these technologies may also be applied to enhance the performance of non-acoustic sensors.

PHASE I: Develop techniques which may be used to reduce the influence of flow noise on sonar performance. Provide recommendations regarding the most promising options. Describe mechanism of operation for most recommended technique, with estimates of effective increase of sonar performance with respect to a simple baseline (flat plate or axisymmetric body) based upon theory or preliminary experimentation. Identify potential concerns or limitations for practical implementation and report findings.

PHASE II: Experimentally demonstrate flow noise reduction concept in turbulent flow for at least one configuration and over a range of speeds. Validate optimization criteria developed in PHASE I. Based on concept success, develop design for application on full-scale underwater weapon or vehicle.

PHASE III: Fully integrate demonstrated technique into Navy underwater vehicle or weapon for full-scale testing.

COMMERCIAL POTENTIAL: Applications for enhanced performance of commercial sonar used for oceanographic research, treasure location, or search and rescue.

N96-111 TITLE: Simulation Based Concurrent Planning and Development System

OBJECTIVE: Identify new and innovative techniques using state of the art hardware and tailored software for developing a system level modeling and simulation capability. develop a pilot implementation of this technology in a modular extensionable fashion capable of simulating Theater Area Defense Combat scenarios to be used by integrated product development teams of contractors and government personnel simultaneously.

DESCRIPTION: New innovative techniques such as embedded virtual reality, fuzzy logic and generalized optimization theories are needed for planning and developing these complex simulation systems. These systems need to address the current technological needs of current Theater Area Defense Combat scenarios while allowing the flexibility and growth needed for the future. They should also encourage, through their design a tighter coupling between top level designer, developer, and war fighters while allowing the implementing modelers, analysts (both contractors and government) to come together to concurrently develop requirements perform trade offs and design future complex systems.

PHASE I: Conduct an analytic feasibility study that proposes a system design, implementation approach and a demonstration plan.

PHASE II: Accomplish system design, develop the prototype technology and demonstrate the proposed technology as part of the PEO Theater Area Defense Combat SIMULATIONs.

PHASE III: Transition to ongoing and planned DOD and commercial distributed simulations.

COMMERCIAL POTENTIAL: Technology gained through this is directly transferable to high order commercial modeling systems especially those that involve complex multi-disciplined subsystems such as automotive, manufacturing, and chemical processing.

N96-112 TITLE: Integration of Operational Simulation with Functional/Behavioral Simulations

OBJECTIVE: Develop a technology which will allow an operational simulation (comprised of interacting models) to stimulate a model of the system under development to disclose function and performance requirements and other system design parameters.

DESCRIPTION: Operational simulations are those which are used to exercise models of engagement for the purpose of determining survivability and probability of kill for a given platform in a given situation. Quite often, these simulations use other models to represent subsystems or environmental conditions. This is facilitated by protocols such as those defined by the IEEE for distributed simulations. The results obtained from such simulations are survivability and probability of kill. Functional/behavioral (F/B) models of systems represent the tasks that a system must perform in order to meet its requirements, and the absolute and relative timing, of those functions. Such a model can be exercised to determine whether indeed the design can meet the need. This creates a need to generate test scenarios which may or may not represent a real life situation, such scenarios are often geared toward worst case. This is problematic, since because the only question being asked is "what may cause a catastrophic failure", when the interesting question may be "how will the system react in a moderately loaded situation when the scenario changes in this way". To help answer this latter question, it is desirable to integrate an operational simulation of a combatant with the F/B model of a subsystem in such a fashion that the scenario of the first will load the second in a real life manner. In addition, this integration should be real-time and two-way; that is, a perturbation in the operational simulation should immediately change the load on the F/B model, and a change to the model (perhaps in response to an overload in the first case) should have an effect on the combatant in its simulated environment.

PHASE I: A PHASE I effort would produce a study of current tool and technologies which are appropriate for such integration; would propose a set of tools to integrate, along with an approach for the integration.

PHASE II: A PHASE II effort would produce either 1) a tool set which, when used in conjunction with various existing tools, allow the desired simulation capability; or 2) a set of tools which embed the desired technology. In either case, the approach and implementation would be documented to assist further work in this area. The effort would also produce a demonstration of the tools on an example to be determined.

PHASE III: A PHASE III effort would produce a commercial quality toolset or technology that can be applied to various domains and toolsets.

COMMERCIAL POTENTIAL: This effort will have potential in commercial procedural systems, such as factory production lines, and to commercial subsystems which support the procedural ones, such as robotics. It would allow for communication between operational engineers and electrical or mechanical engineers that will produce a system with known behavior in real situations.

N96-113 TITLE: Methods for the Networking and Control of Military Data

OBJECTIVE: Develop a methodology and toolset for managing data in military applications sharing an intelligent high performance computing network.

DESCRIPTION: The Gulf War showed the need for a system for managing large amounts of surveillance and targeting data together with the assets which gather data. Data is supplied by satellites, Defense Mapping Agency maps, intelligence sources and local information from commanders and pilots, etc. A world-wide network for receiving and transmitting data and accessing complex networks of data bases is needed to manage data needed at a point of military action (Command and Control Center). A method for managing data which focuses in extensive real-time parallel computing and geographic distribution is sought, i.e., a way of combining high performance computing and a very high speed communications network. The exploitation of the potential of such an environment will require a new paradigm, supported by computer-aided tools, for transfer of real-time military applications from the present environment to the network. A key aspect of the paradigm is that it is used throughout the application life cycle. Simulation and optimization will be used for intermediate redesign for parallelism, as well as for selecting optimal allocation of resources at run time. The supporting toolset should be integrated to existing systems analysis and development tools (such as Computer Aided Software Engineering (CASE) and/or simulation and should complement existing technology.

PHASE I: Develop methods and demonstrate application in a Laboratory Network (Sun SparcStation Network).

PHASE II: Develop an automated prototype system, including software tools. Demonstrate the system using Navy Communication Data network such as Link 4a, Link 9, Link 11, Link 16, etc.

PHASE III: Improve prototype system and install on a Navy ship Command and Control Center for trials.

COMMERCIAL POTENTIAL: Applicable to large computer systems which need to share resources. Examples are communication (telephone) manufacturing and air traffic control.

REFERENCES:

(1) Bianchini, Jr., R. and Shen, J.P., "Interprocessor Traffic Scheduling Algorithms for Multiple-Processor Networks", IEEE Transactions on Computers, Vol. C-36, No. 4, April 1987.

(2) Bowen, B.A., Brown, W.R., System Design: Volume II of System Design for Digital Signal Processing, Prentice-Hall, Inc., 1985

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(5) Howell, S., Nguyen, C., Hwang, P., "Design Structuring and Allocation Optimization (DeStinAtion): A Front-end Methodology for Prototyping Large, Complex, Real-Time Systems", Pro. Hawaii International Conference on System Sciences, IEEE Computer Society Press, Los Alamistos, CA, Jan 1992, Vol. II, pp 517-528.

N96-114 TITLE: Methodology to Predict Ballistic Penetration and Damage of Composite Laminated Structures

OBJECTIVE: Develop and deliver a methodology to predict penetrator and target terminal ballistic responses for projectiles and warhead fragments impacting composite laminated structures. The methodology will also be applicable to Theater Ballistic Missile type targets.

DESCRIPTION: Current utilization of composite materials in air and surface weapons systems and structures is extensive, and the use of these materials is expected to increase in the future. Weapons effectiveness assessments and the design of protective structures require methodologies to predict the terminal ballistic interactions between projectiles and fragments penetrating composite laminated target structures at speeds up to 5 km/sec. Penetration and response models for isotropic, metallic and nonmetallic material are well developed. A similar methodology for application to orthotopic, laminated structures of fiber reinforced materials is needed. The methodology will be incorporated in a stand-alone computer program, and the Government shall be granted full license to employ and operate this computer software in multiple sites.

PHASE I: Identify principal penetrator and target response mechanisms, provide a limited demonstration of key concepts, establish an analytical basis for methodology development, and provide a detailed plan for methodology development. Report the methodology development plan and include full details on testing, computations, and other work required for PHASE

II.

PHASE II: Develop objective prediction methodology for selected materials. The prediction methodology will be incorporated into a stand-alone computer program. Full documentation of the use of the code will be provided through a technical report.

PHASE III: Extend methodology to new materials and structures. Install methodology in commercial and government computer codes.

COMMERCIAL POTENTIAL: Commercial uses include predicting hazards and damage from terrorist actions against commercial aircraft and helping develop designs to minimize damage. The technology will be applicable to analyzing damage from flying pieces of failed jet turbine or other debris striking composite air frame and crew structures. The methodology also applies to evaluation of composites for use as light weight shielding to protect against inadvertent industrial explosions and rotating machinery (engines, flywheels, armatures, etc.) failures.

REFERENCES: Penetration Equations Handbook for Kinetic-Energy Penetrators (u) 61JTCG/ME-77-16, Rev. 1 - JTCG/ME, 15 October 1985

N96-115 TITLE: Low-Cost, Lightweight Rocket Nozzle Materials for Tactical Missiles

OBJECTIVE: Develop a low-cost fabrication technique for continuous-fiber-reinforced ceramic matrix composite tactical rocket nozzles.

DESCRIPTION: Current tactical rocket motors utilize multi-segment nozzles with tungsten or graphite throats. Although both materials have provided satisfactory performance, significantly improved design flexibility, reduced cost, and reduced nozzle complexity (with attendant improved reliability) is believed possible with ceramic matrix composite (CMC) materials. The use of a low density CMC to replace tungsten would provide improved missile design flexibility from a weight/CG perspective. The replacement of graphite with a structural, oxidation-resistant CMC would also provide improved missile design flexibility from, a performance (range, velocity, etc.) perspective. With a low-cost fabrication technique, a one-piece CMC nozzle shell could reduce overall motor cost and improve system reliability. In addition, a flexible fabrication process for a broad range of matrix materials (carbides, borides) would provide for future nozzle needs by enabling the relatively simple optimization of nozzle composition. Thus, the nozzle material development cost could be kept low for future needs such as for advanced propellants (high-performance and/or environmentally benign) and advanced concepts (pulse motors, hybrid solid/liquid).

PHASE I: Identify a low-cost fabrication/processing approach for continuous-fiber-reinforced CMC nozzle shell geometries. Fabricate simple geometry components, such as rings or plates, and subject these components to critical mechanical testing to verify viable properties over the desired use temperature range. The PHASE I effort shall also show how the fabrication approach provides wide tailorability of the matrix composition.

PHASE II: Technologies required to demonstrate the fabrication/processing approach shall be developed and representative nozzle components shall be produced. A component demonstration plan shall be prepared which identifies a suitable demonstrator motor, identifies critical material properties, fabricates and characterizes sufficient material to confirm the material capability for the test. A representative motor demonstration test shall be performed.

PHASE III: The selected material shall be qualified for the selected motor application.

COMMERCIAL POTENTIAL: The developed material fabrication approach would have broad application to the manufacturing of low-cost, high-temperature structural materials. The technology could be applicable to advanced commercial gas turbine engines for aircraft or for power generation. In addition, the materials technology could significantly reduce the cost of advanced composites for satellite propulsion and earth-to-orbit vehicle applications.

REFERENCES:
1. Kardell, M.P., et al., "Arc-Heater Ground Testing of Oxidation-Resistant Carbon-Carbon Materials," NSWC TR 87-32 (Feb 1987). (Avail DTIC)
2. Baskin, Y., et al., "Failure Mechanisms of Solid Propellant Rocket Nozzles," Ceramic Bulletin, Vol. 39, no. 1, (1960), pp. 14-17.
3. Campbell, J.G., "Refractory Chamber Materials for N204/Amine Propellants," AFRPL-TR-73-31 (May 1973). (DTIC AD-762531)

N96-116 TITLE: Photonic Controlled True-Time-Delay Wide-Band-Radar

OBJECTIVE: To develop photonic controlled true-time-delay components for an active, wide-band, phased array radar system.

DESCRIPTION: Due to the recent advance in Monolithic Microwave Integrated Circuit (MMIC) technology, the next generation Navy radar system may feature an active solid state phased array radar. The future need to consolidate Navy radar functions to reduce the number of antennas aboard a ship demands some form of the Shared Aperture Concept. The complexity associated with controlling the many thousand arrays elements, while handling the broad bandwidth of the shared aperture configuration, makes the marriage of photonics and microwave radar attractive. In particular, the envisioned photonic system will provide a True Time Delay Beam Forming Network, as well as phase and/or amplitude control of each individual element. An innovative photonic scheme to deliver the True Time Delay components is solicited. The emphasis is on compactness and control simplicity within the system.

PHASE I: Survey and compare the possible photonic sub-systems, and provide an optimal scheme with rational justifications for a complete system utilizing the sub-components. Provide a prototype system design.

PHASE II: Develop, fabricate and test the prototype system. Submit design disclosure drawings and test methods and procedures for Government approval, conduct the testing in a laboratory environment, and report test results to the Government.

PHASE III: Transition to Advanced Electronic Counter Measures Transmitter or other advanced radar programs.

COMMERCIAL POTENTIAL: Highly directive satellite communications of broad bandwidth is an anticipated commercial usage of this research.

N96-117 TITLE: Target Discrimination Techniques for Infrared Search and Track

OBJECTIVE: The development of innovative algorithms to improve the separation of real from false targets in planned Infrared Search and Track (IRST) systems.

DESCRIPTION: Automatic infrared surveillance systems are plagued by the difficulty of separating the infrared emission from real intruders from those of an active environment because they react to increases in the radiant intensity of all sources. This problem is compounded in a scanning shipboard IRST system which generates several million samples of data per second for spatial filtering and signal processing. These data typically result in many threshold exceedances which may be due to target (e.g. aircraft or missiles) but are mostly due to clutter (e.g. clouds or sea reflectance). The exceedances produced by the signal processor must be further processed by target versus clutter discrimination algorithms to automatically select and track the targets. Innovative approaches to exploit advanced tracking techniques, such as estimation theory or hypothesis testing, are needed in new discrimination algorithms. The end result should be a tracking and discrimination routine which increases the probability of target declaration while decreasing the probability of false alarm.

PHASE I: Develop an advanced IRST track discrimination algorithm and demonstrate feasibility in laboratory testing.

PHASE II: Develop, fabricate and test a proto-type capable of being applied to a scanning shipboard IRST system. Submit design disclosure drawings and test methods and procedures for Government approval, conduct preliminary testing in a laboratory environment, report results of preliminary testing to the Government, and participate in Navy testing of the IRST track discriminator installed in a system.

PHASE III: Implement hardware and software for IRST track discrimination into an operational Navy IRST.

COMMERCIAL POTENTIAL: Algorithms can be applied to automatic surveillance and alarm systems. Commercial ship IRST for navigation or station keeping. Aircraft IRST for Navigation and collision avoidance.

REFERENCES:
(1) S. S. Blackman, "Multiple-Target Tracking with RADAR Application," Artech House, 1986.
(2) Y. Bar-Shalom, T.E. Fortmann, "Tracking and Data Association," Academic Press, 1988.

N96-118 TITLE: Miniature Two Color Infrared Detector

OBJECTIVE: The development of a low cost, miniature, two infrared wave bands (colors) detector. The detector will be integrated with two color signal processing under development to provide a proximity fuse for Navy 5"/54 projectiles.

DESCRIPTION: The Navy is interested in advanced infrared projectile fuzing for use against air targets. Current single wave band (color) fuzes will be incapable of engaging both powered and unpowered targets with reduced (stealth) infrared signatures. An effort is underway to develop a two color infrared proximity fuse for Navy 5" artillery rounds. This fuse will perform target discrimination through use of two colors in the mid infrared wave band (3.0-5.0 um) or alternatively 1 color in the mid with one in the long infrared wave band (7.8-12.0 um). A low cost miniature two color uncooled detector array is needed for use in the proposed fuse. Detector elements should be procured and miniaturized or constructed based on current technology. The goal is to integrate the detector array and signal processing chips under development to fit 5"/54 artillery round fuzing.

PHASE I: Propose a 2 color detector system for use in a proximity fuse in Navy 5"/54 artillery rounds. Detectors should fit current 5"/54 fuse designs which employ 4 detectors mounted so that their instantaneous fields of view are 90^0 with respect to the circumference of the shell (single wave band) detector systems should cost less than $100. per round and be suitable for close proximity (100 feet or less) detection/discrimination. Deliver a feasibility study on a detector system which best meets all fuse requirements.

PHASE II: Build and test prototype detector arrays and integrate them with a signal processor currently under development for 2 color detection/discrimination. Provide static testing of the integrated device versus ground sources. Participate in possible Navy flight tests to verify fuse performance.

PHASE III: Optimize the detector system for performance, a miniaturize and engineer for low cost. Detector system will be included in a proposed planned product improvement or in the development of a new infrared fuse for Navy 5"/54 gun fired projectiles.

COMMERCIAL POTENTIAL: Two color infrared detectors with discrimination signal processor can be used in aircraft collision avoidance warning systems. Other uses include false target discrimination for detection in security/surveillance systems and in robotics/machine vision devices. A novel use for the infrared detection/discrimination technology would be in an automotive warning device against road hazards caused by solar glare, oil, water buildup or obstacles.

REFERENCES:
(1) Low-Cost Signal Processor for Passive, Multi-Band IR Fuse, SBIR Topic No. N91-345.
(2) Infrared Sky Clutter Suppression Using Uncooled Two-Color Sensors; H.R. Riedel, A.C. Bouley, T.K. Chu, R.J. Goetz; October 1883; NSWC TN83-368.
(3) Metal-Semiconductor Mesh Technology: A New Basis for Infrared Detector Array Structures; T.K. Chu; October 1983; NSWC TN83-446.

N96-119 TITLE: Transmit/Receive (T/R) Module Cost Reduction Through The Use Of Taguchi Design Of Experiments

OBJECTIVE: The objective of this work is to lower the cost of T/R modules by applying Taguchi design of experiments to T/R module manufacturing techniques and T/R module subcontractor (housing and substrate) manufacturing techniques.

DESCRIPTION: Taguchi design of experiments can be used to identify, control, and tolerance process/manufacturing variables efficiently to ensure high yields (low cost). A large percentage of T/R module cost is associated with assembly labor and packaging materials. This effort would utilize Taguchi methods in the manufacturing T/R module assembly costs and the cost of manufacturing T/R module packaging materials (e.g. housing and substrate).

PHASE I: Identify and report the T/R module packaging and substrate cost drivers and explore ways to develop lower cost and lighter weight T/R module packaging and substrate materials. Analysis is to be conducted to investigate potential lower cost or lighter weight systems or concepts. Functional characteristics subject to Taguchi DOE improvements will be reported. Identify controllable and noise factors for potential systems/concepts. Provide system models with associated plans to implement Taguchi Design of Experiment philosophy in each potential system/concept process or product. Report on most favorable approaches and likelihood for each approach to achieve lower cost and or lower weight products.

PHASE II: Conduct experiments for the most promising system or concept reported in PHASE I. Formal Taguchi DOE to be conducted for most promising system/concept, subject to Government concurrence in the selection. Process/product factors affecting functional characteristics of the selected system/concept will be identified and classified as controllable or noise. Assessment of impact and interactions will be conducted for these factors and Taguchi arrays developed to maximize orthogonalities and improve signal to noise ratios. Additional analysis will be performed on the next selected alternative if the results of the first selected system/concept do not optimize T/R module packaging or substrate supply cost. Results of the Taguchi analysis will be reported with recommendations of designs/process parameters which will assist in lowering cost and/or lowering the weight. Expected cost/weight improvements will be determined. Weight reduction will be a goal, but will nor

compromise experiment results.

PHASE III: Process/product parameters will be transitioned into commercial designs for T/R packaging and substrate, on the basis of cost reduction (Primarily) and weight reduction (Secondarily). .

COMMERCIAL POTENTIAL: Many Wireless products receive and transmit signals at microwave frequencies (cellular Phones) and rely on the same technologies at military T/R module vendors. This project will make suppliers of these technologies more efficient and will lower manufacturing costs for both commercial and military vendors.

REFERENCES: " Quality Engineering and Production Systems", Genichi Taguchi, 1989

N96-120 TITLE: Continuous Wave Mid-Infrared Laser Sources

OBJECTIVE: Develop technology in 3-5 micron, continuous wave, medium power lasers and monolinear optics.

DESCRIPTION: Solid state and gas mid-infrared lasers are generally operated in the pulse mode to provide sufficient peak power for efficient conversion in optical parametric oscillators and harmonic generators, respectively. The cw or pulsed chemical DF laser has size/weight and potential safety constraints for certain operational platforms. Innovative proposals are sought to explore the potential of new solid state and/or gas laser sources to generate cw (or pulse repetition frequency 50-100 Khz if pulsed) output powers of 10 watt or greater on laser lines that operate in the 3-5 um atmospheric transmission windows and with mode quality that does not exceed 2 times diffraction limited.

PHASE I: Explore concepts from an analytical and/or experimental perspective to determine the feasibility of a cw/high prf MIR laser meeting the average power, wavelength and beam quality requirements. The study shall address the design and performance of a system to be fabricated in Phase II as well as power scaling issues in achieving > 10w output power.

PHASE II: Design,fabricate,test,and deliver a fieldable prototype, compact, cw/high prf,10w, MIR laser system. The laser shall also meet wavelength and beam quality requirements.

PHASE III: The technology will be transitioned to a test facility such as the Navy's Chesapeake Bay Detachment for integration and characterization with the Multi-Band Anti-Ship Cruise Missile Tactical Electronics Warfare System (MATES) and other DoD related systems requiring directed IRCM.

COMMERCIAL POTENTIAL: Other possible applications include the use of such a laser source for nuclear proliferation monitoring, process control, medical surgical systems, and pollution sensing of hydrocarbon molecules.

REFERENCES: S. N. Tskhai, et al, Appl. Phys. Lett., vol. 66, no.7, 1995. (2) Private communications.

N96-121 TITLE: Electrorheological Fluids

OBJECTIVE: Develop electrorheological fluid(s) that will provide shock dampening for ship mounted equipment and adjustable recoil performance for navy gun weapons.

DESCRIPTION: An electrorheological (ER) fluid is one which is transformed from a liquid into a viscoelastic solid upon application of a strong electric field. The three main aspects of the ER technology are: (1) the ER device, (2) the ER fluid, and (3) the power/control circuitry. This technology has broad Navy application for shock isolators on shipboard equipment, as well as for providing adjustable recoil systems for Navy gun weapon systems. This task will focus on shock dampening initially as a less demanding research effort.

PHASE I: Develop an ER fluid that will provide optimum shock dampening for Navy equipment assuming acceleration in the vicinity of 10 g's.

PHASE II: Develop the ER device and control circuitry that will support the effort.

PHASE III: Conduct barge and shock table tests to verify performance.

COMMERCIAL POTENTIAL: Shipping industry, transportation industry, electrical power industry

REFERENCES: "Electrorheological (ER) Fluids, A research Needs Assessment Final Report", US DOE Office of Program Analysis, contract DE-AC02-91ER30172

N96-122 TITLE: Broadband Acoustic Processing Technologies

OBJECTIVE: Develop algorithms for tactical passive or active broadband processing in the mid-frequency range.

DESCRIPTION: Innovative signal processing algorithms in the mid-frequency range are required in response to changing operational requirements, especially in the shallow waters of coastal environments. Current acoustic signal processing is based on narrowband assumptions. To date, proposed broadband algorithms are evolutionary extrapolations from existing narrowband work rather than revolutionary. Consequently, highly innovative algorithm development is sought to handle either the passive processing or the active processing problem. Proposals should focus on one problem or the other. The following elements are common to both: beamforming; clutter reduction; and improved detection, classification, and localization.
Additional elements of particular interest to the passive broadband area include, but are not limited to: trackers; full spectrum processing; data fusion; acoustic contact correlation. Algorithms may address one or several elements of the passive processing problem. In the active area broadband area, algorithm development should focus on improved detection of coherent signals from bottomed submarines and mines and enhanced reverberation suppression from bottom, volume, and boundary layer phenomena.

PHASE I: Develop, describe and implement the new algorithm.

PHASE II: Provide non real-time demonstration of the algorithm using Navy provided data for the passive case and a Navy provided wideband acoustic source to generate signals for the active case. Provide source code.

PHASE III: Demonstrate real-time performance enhancements of new algorithm with respect to current algorithms, on commercial processing hardware.

COMMERCIAL POTENTIAL: Commercial potential for algorithms developed under this SBIR are dependent on specific problem addressed but include: offshore petroleum exploration; underwater inspection services including environmental assessment; medical imaging technology; and enhanced underwater acoustic communication, for example among divers.

N96-123 TITLE: Multisource/Multireceiver Tactical Decision Aid

OBJECTIVE: To develop a tactical decision aid (TDA) that assesses the various environmental, tactical, and system factors associated with multisource/multireceiver active sonar scenarios and develops effective ASW Commander and shipboard sonar employment recommendations.

DESCRIPTION: The U.S. Navy has in various stages of development several active sonar systems that are designed for or are suitable to bistatic/multistatic applications. These systems include air and surface sonar sources and air, surface, subsurface, and fixed sonar receivers. Properly employed, these sonar systems can dramatically improve ASW performance in a wide range of operating environments. There is a requirement for an integrated decision aid tool that can assess the complex matrix of bistatic/multistatic employment and make optimum source and receiver positioning, sonar system setup, and transmission characteristic recommendations. Innovative solutions are sought that will develop such a tactical decision aid for existing sonar systems.

PHASE I: Design a multi-static TDA that meets the above stated tactical requirement. The deliverables from Phase I will include as a minimum: 1) an operations concept document identifying the intended use of the system; 2) design of input and output screens; 3) algorithm design document for the proposed TDA; and 4) report on the availability of data required to support the designed algorithm.

PHASE II: Develop a computerized tactical decision aid that was designed in Phase I. This tacit should be suitable for employment on board Navy vessels for an evaluation of the system in an at-sea setting. The deliverables for Phase II will include as a minimum: 1) source code of all software developed in support of this SBIR; 2) report on the sea test which includes quantification of the value added by employing the system. The demonstration system should consider leveraging existing acoustic tactical decision libraries, allowing the SBIR effort to focus on developing an innovative tacit. To this end, use of the Joint Maritime Command Information System (JMCIS) should be considered as it is the Navy C41 system for platform location and movement information. Additionally, a Sensor Performance Prediction (SPP) library should be considered for leveraging. One SPP library is the surface ship Sonar In-situ Mode Assessment System (SIMAS). This library contains acoustic models and databases and combat system interfaces which may provide relevant data (e.g. reverberation and ambient noise data).

PHASE III: Produce and market the product for ASW purposes.

COMMERCIAL POTENTIAL: Expected commercialization includes seismic research and oceanographic applications such as active tomography.

REFERENCES:

1) Joint Maritime Command Information System (JMCIS) Common Operating Environment Revision 1.3 of 14 February 1994.
2) Sensor Performance Prediction (SPP) Program Architecture Plan Version 3.0 of February 1994.
3) Surface/SIMAS II Advanced Development Model (ADM) Software User's Guide Version 3.2 of September 1994.

N96-124 TITLE: High Pressure Gear Pumps for Improved Wear Resistance

OBJECTIVE: The improvement of pump performance and service life enhancement of small high-pressure gear pumps is sought through material development and component design and testing. Prototypes of pumps and pump components resulting from material development and testing and/or design refinements will be analyzed.

DESCRIPTION: The gears and sealing surfaces in high performance high pressure gear pumps experience demanding loads applied from high pressure abrasive fluids. The pump components need to be comprised of durable materials maintained at tight tolerances to withstand loading and associated wear during operation. The current components often lend themselves to problems with wear, which reduce flow, pressure, and self-cooling during repetitive operation. Deionized water, being the working fluid, provides primary lubrication and cooling for the pump components. New materials and technologies exist that may prevent unnecessary wear and prolong pump life. The effort should include investigations into new gear materials, removable or replaceable liners for gear sealing surfaces, and improved bearings. Along with material selection, novel designs and design enhancements should be considered. The developed technology would greatly enhance high pressure gear pump performance and extend asset operational life.

PHASE I: Categorize prospective materials for pump gears and develop design concepts for gear sealing surfaces. This effort includes examining gear and bearing design for improved wear resistance while maintaining desired performance characteristics. Small scale bench testing is to be performed on candidate materials to determine wear characteristics. Recommendations on candidate materials and designs are to be provided in a detailed report.

PHASE II: Develop full-scale prototypes based on testing results from Phase I research. These tests are to be developed and conducted to reproduce Navy System operating conditions. They shall include pressure, flow, and endurance evaluations to characterize pump performance, as well as, gear and bearing operating life. Phase II shall culminate in the development full prototype assemblies for incorporation into the Navy application for evaluation. A data package describing in detail the design and testing of the pump assemblies is to be developed and delivered.

PHASE III: The Phase III program would develop level 3 drawings of a final pump configuration to be incorporated into the Technical Data Package for the MK 50 program. This documentation can also be incorporated into other related Navy systems utilizing small, high pressure gear pumps. Phase III would then lead into production of pump assemblies and use in the various Navy vehicle systems and applications.

COMMERCIAL POTENTIAL: Improvements to high pressure gear pumps would have wide applicability in both the Defense and civilian sectors. A number of Navy systems employ gear pumps that must endure repeated and extended operation in critical roles. These systems may be upgraded through this research to further enhance their performance and operational life. Many commercial and industrial applications would benefit from pumps that are able to transmit abrasive and elevated temperature fluids and endure prolonged operation.

N96-125 TITLE: Peacetime Use of the Adaptable High Speed Undersea Munition (AHSUM)

OBJECTIVE: To adapt munition and the launcher for military and civilian applications. To test the concept for the selected applications.

DESCRIPTION: AHSUM is an undersea munition that travels at speeds exceeding 600 m/s and possibly as high as 2000 m/s. It is normally gun-launched, and may be provided with a rocket propulsor. Long term development potential includes smart variants. The high speeds of the munition make it capable of kinetic penetration of a variety of undersea targets. AHSUM is under consideration for a variety of peacetime applications, mostly in the offshore industry. Such concepts as an inexpensive bottom penetrator system, a tension leg platform mooring system, and a new type of acoustic source for coastal geotechnical work have been proposed. Assistance is required in identifying and downselecting practical applications of importance, adapting the munition and the launcher, and testing the concept for selected applications.

PHASE I: Develop a set of operational requirements for the munition for each application. Using existing performance data and military operational goals (to be Government furnished), assess the prospects of success of each

application. Identify commercial uses of AHSUM not listed below.

PHASE II: Demonstrate the effectiveness of specific AHSUM variants for selected military and peacetime applications in cooperation with the United States Navy.

PHASE III: The military development of AHSUM would transition to the fleet via any of several weapon system development programs, including PE#101226N Submarine Defensive Warfare System, PE#0603506 Surface Ship Torpedo Defense, PE#0604558N New Attack Submarine, and PE#0603502 Mine Countermeasures.

COMMERCIAL POTENTIAL: The low cost of AHSUM, (especially if commercial markets are developed) makes it an ideal candidate for any offshore application requiring effective inexpensive rapid safe kinetic penetration capability. Proposed applications in the offshore industry include inexpensive bottom penetration, tension leg mooring of offshore platforms, and littoral geo-technical and oceanographic applications such as cavitation-based broadband acoustic source, bottom penetrating detonation sources capable of reaching the upper strata for geo-physical mapping and exploration and rapidly moving sensors for mapping time-dependent phenomena. Interest in pursuing such applications has been expressed by experts in the offshore industry. Other applications include uses in sport diving, marine biology, undersea construction, and safe undersea storage of spent radioactive fuel.

REFERENCES:

1. Kirschner, I.N., and L.M. Dean (1995) "Mid-Range Land-Based Tests of the Adaptable High Speed Undersea Munition (AHSUM)," NUWC-NPT Technical Report (in progress), Naval Undersea Warfare Center Division, Newport, RI
2. Kirschner, I.N., A.N. Varghese, and J.Q. Rice (1994) "Supercavitation Drag Reduction in High-Mach-Number Liquid Flows," NUWC-NPT Technical Memorandum 942043, Naval Undersea Warfare Center Division, Newport, RI
3. Stace, J.J., L.M. Dean, and I.N. Kirschner (1994) "Face Seal Technique for the Exclusion of Water From Underwater Gun Barrels," NUWC-NPT Invention Disclosure, Navy Case Number 76643, Naval Undersea Warfare Center Division, Newport, RI
4. Kirschner, I.N., L.M. Dean, and R.B. Philips (1995) "Spooled Metal Tape Seal for Underwater Gun Operation," NUWC-NPT Invention Disclosure, Navy Case Number 76837, Naval Undersea Warfare Center Division, Newport, RI

N96-126 TITLE: <u>Low Cost Underwater Mateable Fiber Optic Connector</u>

OBJECTIVE: To develop a low cost underwater mateable multi-mode fiber optic connector to support submarine hull mounted array short haul communications.

DESCRIPTION: Placing electronics outboard of a submarine pressure hull in support of hull mounted arrays has many advantages. In order to support high speed telemetry and ground isolation for the outboard electronics, a fiber optic communication link is desirable. To perform array/sub-array replacement without drydocking it is necessary to develop an underwater mateable connector. The connector should be mateable by a diver. A single fiber and/or a duplex fiber design should be considered. The receptacle end of the connector shall mount on a stainless steel plate that is part of the pressure housing for the electronics. The receptacle should protrude into the pressure vessel less than a half (1/2) inch. The connector housing should not corrode in the presence of Titanium or 316 CRES. The plug end should mate to underwater cables such as Rochester Steelite, Mil-C-0085045E, or similar. The plug, including cable strain relief, should not extend more that six (6) inches from the face of the steel plate that the receptacle is mounted on. Optically the connector should use 62.5/125 um multi-mode fiber and should exhibit loss of less than three (3) Db at 1300 nm over a minimum of 50 mating cycles. This performance should be maintained for pressures from ambient to 1000 psig in a seawater environment for up to 20 years.

PHASE I: The effort will result in a study of different connector concepts, predicted performance, and expected construction costs. Breadboard and test most promising concepts.

PHASE II: Develop and test the most promising connector concepts. Produce test report. Deliver several first article units for Navy testing.

PHASE III: The Navy would recommend a successful connector to various Navy hull array programs where fiber optic telemetry is desired and low cost is important.

COMMERCIAL POTENTIAL: This connector technology has direct applications in the commercial sector. Potential users include those involved in underwater telephony, private fiber networks, CATV, and harsh environment local area network environments such as found in many industrial plants.

N96-127 TITLE: Advanced Laser Source for Fiber Optics

OBJECTIVE: To increase the frequency stability, the coherence length, and the optical power of optical fiber-coupled lasers supplying light in the 1310 to 1340 nanometer wavelength range. Overall performance will be increased with the resultant lower noise bandwidth.

DESCRIPTION: The frequency stability, coherence length, and power of a laser source have a direct impact on the noise in a fiber optic system. Fiber-coupled, single-frequency, Nd:YAG (neodymium:yttrium argon) lasers in the 1319 to 1330 nm wavelength range have shown dramatic improvements in amplitude and frequency stability, coherence length, and fiber-launched (effective) optical power. But these improvements have typically been limited by frequency drifts of more than 40 Mhz per hour, coherence lengths of less than 5 km, and fiber-launched optical power of less than 200 milliwatts. Laser performance will be increased in three phases:

PHASE I: Develop ways to stabilize the laser frequency and amplitude, to lower the laser noise to obtain increased coherence length, and to raise the fiber-coupled optical power. Three goals are: (1) obtain a frequency drift of less than 1 Hz per millisecond, 1 Mhz per hour, and 10 Mhz per day as demonstrated by a beat frequency test between two independent prototype lasers; (2) minimize noise bandwidth to provide a coherence length exceeding 30 km; and (3) optimize optical power to exceed 500 Mw into polarization-preserving fiber.

PHASE II: Technology developed under Phase I will be used to fabricate three amplitude and frequency stabilized, 500 Mw, polarization-preserving, fiber-pigtailed, single-frequency lasers in the 1310 to 1340 nm wavelength band. The identical lasers will be portable, and sized to fit into a 19-inch equipment rack.

PHASE III: The three fiber-coupled lasers will be incorporated into an experimental Navy fiber optic sensor system. The Navy will evaluate the improvements in sensor system performance. The laser technology will transition directly into Navy exploratory and advanced development of fiber optic hull-mounted, deployed, and towed acoustic arrays as well as fiber optic gyros.

COMMERCIAL POTENTIAL: The largest non-military applications for this technology are coherent, long-haul, gigabit-per-second telecommunications networks and fiber optic cable television distribution systems requiring hundreds of analog channels. These are rapidly expanding, multi-billion dollar industries.

REFERENCES:
1. "Sub-Hertz Relative Frequency Stabilization of Two-Diode Laser-Pumped Nd:YAG Lasers Locked to a Fabry Perot Interferometer," Timothy Day, Eric Gustafson, and Robert Byer, IEEE Journal of Quantum Electronics, Vol. 28, No. 4, April 1992, p 1106
2. "193-Mhz Beat Linewidth of Frequency-Stabilized Laser-Diode-Pumped Nd:YAG Ring Lasers," Noboru Uehara and Kenichi Uedo, Optics Letters, Vol. 18, No. 7, April 1993, p 505

N96-128 TITLE: Independent Verification And Validation (IV&V) Tool To Monitor The Effects On Navy Enlisted Skills And Knowledge Resulting From Ongoing Changes In Training Technology

OBJECTIVE: Develop an Independent Verification and Validation (IV&V) tool to identify the impact of the move towards increased shipboard training and reduced shore-based training on the skill and knowledge base of Navy personnel. Specifically, provide data that documents the efficiency (in terms of cost) and effectiveness of various shore-based and shipboard approaches to training basic and advanced knowledge and skill. Develop a decision aid (IV&V) tool, based on the nature of skill and knowledge requirements of selected tasks, that helps training designers to determine the optimal setting (and instructional strategy) for training a particular class of knowledge and/or skill.

DESCRIPTION: Recent and ongoing training technology changes have resulted in movement of training traditionally performed in shore based schoolhouses to on board training (OBT) environments. An impact analysis to quantify the trend is needed. A specific area to investigate is the interplay of skills and knowledge acquired in the initial shore based training phases and the subsequent shipboard phases. The analysis should document and describe any interplay, and based on the research, appropriate conclusions and recommendations shall be provided.

PHASE I: Contractor shall develop a conceptual framework to guide research into how best to accomplish training for various knowledge and skills that underlie selected Navy tasks. This framework shall, at a minimum, draw on existing taxonomies of human performance and training, and provide a basis to generate hypothesized associations between required classes of knowledge/skill and available training strategies (both shore-based and shipboard). In addition, Contractor shall

examine the relationship between current shore-based and shipboard training in order to 1) determine redundancy in training objectives, 2) identify training gaps or shortfalls, 3) establish cost/benefit tradeoffs for various training strategies, and 4) generate propositions that suggest the optimal training strategy for various categories of knowledge and skill.

PHASE II: Critically assess and test hypotheses generated by the framework developed in Phase I. Specifically, examine the knowledge/skill requirements of existing Navy courses (provided by the government) to determine the optimal training setting and strategy. Select a subset of hypotheses that can be tested empirically using available test facilities. Contractors shall develop a pilot decision aid (IV&V) tool based on work in Phases I. Based on analytical and empirical effort utilizing the pilot (IV&V), make recommendations for which classes of knowledge and skill are best trained in shore-based facilities and which are best trained on board ship. Extend this analysis to include refresher as well as initial skill training. Document the (IV&V) design and all verification test results.

PHASE III: Contractors shall develop a decision aid (IV&V) tool based on work in Phases I and II. Specifically, this decision aid shall allow training designers (and others) to make sound decisions for how to approach training (in terms of the training setting, strategy, etc.) for
various types of knowledge and skill. The decision aid shall be user-friendly, and applicable to a wide variety of knowledge and skill (as defined in Phases I and II). Its value will be in guiding training systems designers, course managers, and even instructors in making crucial training design decisions. This will help to ensure optimal use of precious training resources, while maximizing training effectiveness and readiness.

COMMERCIAL POTENTIAL: The results are applicable to industries and professions and trades that undergo changing skills, skill levels and introduction of new techniques through technological advancement or other presidents. This includes the legal and health professions, and the transportation, building and utilities.

REFERENCES:

1. Military Training Programs MILSTD 1379D
2. Catalogue of Navy Training Courses (CANTRAC) CANTRAC Course Descriptions and Convening Dates NAVTRA 10500 Volume II
3. Navy Integrated Training Resources and Administration System (NITRAS)
4. Military Handbook (on) Interactive Courseware (ICW) MIL-HDBK-284-1
5. Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards Volumes I and II NAVPERS 18068

N96-129 TITLE: Massively Parallel Processing for Ship Self Defense

OBJECTIVE: Identify new and innovative applications where Massively Parallel Processing (MPP) technology can improve littoral warfare capability while reducing warfighting costs.

DESCRIPTION: The technology for Massively Parallel Processing (arrays of over 1000 matrixed processors) has existed for some time, with most military applications limited to the shore-based "computer center" environment. These systems involved exotic equipment designs, significant data input requirements, complex programming techniques and large power consumption. These attributes have restricted this technology from reaching the battlefield and have kept the enormous potential of MPP away from the hands of the warfighter. Recent breakthroughs in deployable massively parallel processing (MPP) include the down-sizing of processors to 6U VME technology, new software techniques and advanced image processing algorithms that take advantage of the MPP architecture. There have been concomitant reductions in space and weight requirements -- with the current ability to place a 4000 processor array in a tactical environment in less space than most current PCs. These advances occur with concert with marked increases in processor and memory storage capability. These breakthroughs in MPP hardware and software enable simultaneous onboard processing and fusion of multi-sensor data in real-time. MPP technology is ideally suited to the task of turning multi-sensor data into useable information. MPP could be a very powerful capability and force multiplier in the post cold war environment as the Navy prepares to implement advanced ship self defense combat systems supporting littoral warfare. Embedded data-parallel super-computing technology offers the ability to employ advanced programming techniques in real-time to successfully fuse multi-source data and enhance the Commanders ability to extend, visualize, manage and control his Battlespace. New and innovative MPP technologies and applications are needed for Green and Brown water operations which will increase combat systems capabilities, aid in Battlespace Management, reduce human exposure and risk, show an overall system cost reduction and conform to the Next Generation Computing Resources open systems architectures philosophy.

PHASE I: Identify existing, and define new, fleet systems that would benefit from the application of MPP technology. Outline each system's architecture, identify software development requirements utilizing advanced image processing techniques,

and identify any required modifications/enhancements to existing systems. Demonstrate and select specific methods of video data compression and processing using deployable massively parallel processing super-computers. Identify the expected system performance improvements in multi-sensor processing, data fusion, and the potential bandwidth for a suite of sensors in an on-board application.

PHASE II: Confirm the feasibility of applying MPP technology and custom software to a selected system through a cost-effective demonstration, such as a partially simulated environment. Demonstrate the improved security and data compression techniques for advanced sensor imagery propagation through prototyping and in-fleet. Prepare a transition plan to fully demonstrate the implementation in an operational scenario.

PHASE III: Procure systems based on proven Phase II demonstration, utilizing deployable MPP technology for use in selected existing and planned sensor and reconnaissance systems.

COMMERCIAL POTENTIAL: Developing a system capability which brings more digital processing power to the end user, especially in an open systems environment, has many applications in a commercial environment. Many combat systems/functions apply to the high-tech/high-risk environment.; such as: commercial aerospace or law enforcement sectors of the economy. Increased digital processing will also benefit, the air traffic control sector, and any industry with remote sensing or multi-source data fusion requirements.

STRATEGIC SYSTEMS PROGRAM OFFICE

N96-130 TITLE: Thermal Enhanced Electronic Component Bond

OBJECTIVE: To develop a high thermal conductivity bond for electronic components which can be debonded easily and without high temperature.

DESCRIPTION: Previous thermal enhanced bonds have used high conductivity bond materials or have added high thermal conducting materials in particle or whisker form to the bonding material. The bonds which are high conductivity materials usually are formed at high temperatures and can not be easily debonded without high temperatures, if at all. High temperatures damage sensitive electronic components. This type of bond includes brazing, welding, graphatizing and carbonizing, etc. The other type of bond which has high thermal conductivity materials added still has low relative thermal conductivity because the epoxy or thermoplastic bond matrix has a very low thermal conductivity to begin with. The added materials include silver, gold, iron, aluminum, copper, etc. The low composite thermal conductivity of these materials is a function primarily of the relative amount of matrix compared to the amount of particles that heat must traverse to get from one bonded material to the other.

PHASE I: Provide design for high thermal conductivity bonds between doublers and electronic components using carbon-carbon fabrics. Compare the design bonds performance with the performance of bonds containing high thermal conductivity particles and whiskers. The designs should include different material doublers, such as carbon-carbon and aluminum.

PHASE II: Using the designs determined in Phase I to bond and test materials and determine the thermal conductivity across the bonds. Based on these tests and additional analysis, determine optimum bond designs(s) and materials or material systems.

COMMERCIAL POTENTIAL: The produced thermal conductivity enhanced bond design has commercial potential to effect almost all electronics, as well as, any other application where high conductivity and easy bond disassembly is desired.

N96-131 TITLE: Global Positioning Satellite (GPS) Simulator for Re-entry Body Application

OBJECTIVE: Develop a multi-channel dynamic GPS simulator to provide error-corrupted navigation solutions to a re-entry body trajectory computer simulation.

DESCRIPTION: Existing commercial multi-channel GPS signal simulators are capable of providing 5 to 10 channels of navigation data modified to account for simulated vehicle motion. However, the embedded motion modules in these simulators are not capable of generating realistic reentry body dynamic conditions. The innovation requested here is the development of a GPS signal simulator which can be used in conjunction with a GPS receiver as hardware in the loop elements of a re-entry body computer trajectory model. The trajectory model will provide body position and angular coordinates as inputs to the GPS signal simulator through an interface. The simulator will then provide the appropriate signals to a GPS receiver, which will

furnish positional coordinates back to the computer trajectory model via an interface such as an IEEE 488. The innovation is limited to the GPS signal simulator and the required interface hardware and software.

PHASE I: Perform a preliminary design of the GPS signal simulator and interfaces, and demonstrate feasibility, using a generic GPS receiver, including how body position, velocity, acceleration, antenna-obscuration, antenna pattern rotation with the vehicle, etc. alter the simulated GPS RF signal.

PHASE II: Develop a prototype of the GPS simulation which will input vehicle dynamic descriptors (e.g. vehicle angular velocity and acceleration) and which will include a Navy specified GPS receiver to provide a stream of navigation coordinates via a standard interface. The contractor must document all work performed under this program.

PHASE III: Improvement and sale of simulation and support services to interested government facilities.

COMMERCIAL POTENTIAL: The most obvious commercial or non-DOD use is in the testing of proposed receivers/navigation algorithms intended to operate in high dynamic environments.

REFERENCES: Boulton, Peter, "Study of Error Sources Relating to Test and Development of GPS Receivers for Attitude Sensors in Low Earth Orbit", Institute of Navigation GPS Proceedings, Sept., 1994.

N96-132 TITLE: Inspection System for Large Ductile Iron Castings

OBJECTIVE: Develop a real time, radiographic inspection system for large ductile iron castings.

DESCRIPTION: The Navy is involved in a Cast Ductile Iron Program which produces large parts by casting ductile iron. Occasionally, small and large porosities and voids are formed during the casting process. The Navy, in the past, has used ultrasound techniques to detect these defects in cast ductile iron castings. The ultrasound measurement technique requires a good coupling between the transducer and the casting in order to accurately detect the flaws. This coupling, in some cases, is difficult to maintain. Large castings lead to even greater problems since large water tanks are required for the coupling. The Navy is interested in finding better, faster, and more efficient inspection techniques for laboratory as well as production applications. Real time radiography is one of the methods which may prove to be successful.

PHASE I: Develop a system designs and carry out experiments to determine applicability and performance of a real time inspection system. The emphasis of the system design should be on the speed and accuracy of the inspection system in an automated production environment.

PHASE II: Fabricate and test the Phase I design and develop the prototype system, to include automated inspection, for evaluation during this phase.

PHASE III: The development of an automated, production oriented, real time inspection system for Navy facilities.

COMMERCIAL POTENTIAL The need for a speedy and accurate inspection system exist in the commercial areas where cast ductile iron is used. This may include automobile and other industrial parts.

NAVAL MEDICAL RESEARCH and DEVELOPMENT COMMAND

N96-133 TITLE: An Automated Test Battery for Advanced Aviator Aptitude Assessment

OBJECTIVE: Develop a computer-administered test battery that predicts pilot performance.

DESCRIPTION: This requirement is for a computer-administered test battery that measures aptitudes and other enduring characteristics related to effective performance as an operational Naval and Marine Corps aviator. The Navy has developed and now implements the FAR (flight aptitude rating) battery, which is used to select persons for Naval Aviation Training. Classification, i.e., aircraft assignment, is based on individual preference, performance in undergraduate pilot training, and aircraft availability. We want to explore the possibility of a new test battery (and new tests) that could be used for selection as well as in the classification process. In particular, there is a need to identify and measure aptitudes and other traits that predict which pilots will develop the highest levels of operational flying skills. Additionally, the current tests are administered to over 20,000 applicants at recruiting stations throughout the country. We are interested in having selection tests that can be remotely updated to insert prototype questions and in "real time" continuously improve the selection instrument.

PHASE I: The contractor will provide recommendations regarding content of the test battery and demonstrate feasibility of the test(s) in the battery which can be remotely updated and accessed via connectivity such as the internet.

PHASE II: Produce a reliable and validated test battery to operate on a personal computer such as the 486/33 microcomputer which can send test answers and receive updated test instruments through remote access to a central naval selection computer server.

PHASE III: An easily administered tool for selection and classification of a complex task, such as piloting modern, combat aircraft, would easily transition to other branches of the government as well as to the private sector.

COMMERCIAL POTENTIAL: Potential for a predictive test battery would allow/enhance the selection and placement of personnel in a complex work (task) environment such as public transportation, complex equipment operation or certification requirement standardization, as in motor vehicle operators license procedures.

REFERENCES:

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2. Carretta, T. R. (1992). Recent developments in U.S. Air Force pilot candidate selection and classification. Aviation, Space, and Environmental Medicine, 63, 1112-1114.
3. Griffin, G. R., & Mosko, J. D. (1977). Naval Aviation Attrition 1950-1976: Implications for the development of future research and evaluation. Pensacola, FL: Naval Aerospace Medical Research Laboratory. (NAMRL - 1237).

N96-134 TITLE: Tests of Dynamic and Temporal Visual Acuity

OBJECTIVE: Develop a predictive test battery to assess transient and dynamic aspects of vision.

DESCRIPTION: Many naval activities are visually based and depend heavily on a person's ability to detect or recognize an object (target) that is only partially detailed and/or only briefly presented. Often the target is moving or is one of multiple possibilities in the visual field. The ability to quickly move from one to another and to extract distinctive key visual information is critical for successful performance. Although there has been major advances in understanding temporal factors, the need exists to incorporate this recent knowledge into a test battery which assesses temporal factors in vision.

PHASE I: Show the feasibility of constructing a temporal factors test battery.

PHASE II: Development and demonstrate of the practical value of the test battery.

PHASE III: Demonstrate applicability to other government agencies and to non-military organizations. Produce and market the test battery.

COMMERCIAL POTENTIAL: A test battery which assesses temporal factors in vision would find application in any commercial or civilian activity requiring detection and/or recognition of moving objects. For example, driving a car or truck; piloting aircraft; or police work. Quality control involving visual inspection of moving objects (assembly lines) is another area.

REFERENCES:

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3. Secrist, G. E., & Hartman, B. O. (1993). Situational awareness: The trainability of the near-threshold information acquisition dimension. Aviation, Space, and Environmental Medicine, 64, 885-892.

N96-135 TITLE: Improved Performance Test Battery

OBJECTIVE: Development of a test battery to detect and measure impairment of a person's readiness to perform their job in the workplace.

DESCRIPTION: Many factors can effect a person's readiness to safely and efficiently perform assigned function in the workplace. A need exists to assess any impairment in a person's readiness to work. A portable test battery is a requisite part of such an assessment program. This should not only be usable and valid before a person enter a work environment but it should also be extended to continuous monitoring of the personnel while in work places such as the cockpit of a naval aircraft.

PHASE I: Demonstrate the feasibility of constructing a test battery and recommend procedures for integrating the

battery into the larger assessment program.

PHASE II: Develop the battery and overall program requirements for an assessment program.

PHASE III: Produce and market the test battery.

COMMERCIAL POTENTIAL: The need to assess fitness-for-duty in behavioral terms is felt in civilian as well as military life. Hence, successful fitness-for-duty tests and programs developed in the military might have wide application in civilian industries and occupations.

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2. AGARD (1989). Human performance assessment methods. (AGARD-AG-308), AMP Working Group 12 and AGARD Lecture Series 163. ISBN 92-835-0510-7.
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6. Otto, D. A., & Eckerman, D. (Eds.) (1985). Workshop on Neurotoxicity Testing in Human Populations. Neurobehavioral Toxicology and Teratology, 7(4), 283-420.
7. Kane, R. L., & Kay, G. G. (1992). Computerized assessment in neuropsychology: A review of tests and test batteries. Neuropsychology Review, 3(1), 1-117.

N96-136 TITLE: Rapid Detection of Pathogenic Campylobacter Bacteria Using a PCR/Immunoassay System

OBJECTIVE: To develop and field test a three step system for the detection of pathogenic Campylobacter spp. from fecal samples using a combined polymerase chain reaction (PCR) / antibody assay.

DESCRIPTION: Diarrheal diseases caused by Campylobacter spp. are a major cause of travellers' diarrhea and morbidity in military forces deployed overseas. In an operational setting, Campylobacter-mediated diarrhea has resulted in epidemics aboard ships and among troops deployed ashore. In the civilian sector, pathogenic Campylobacter remains a major contaminant of poultry and other farm products, resulting in significant illness in the general population. Despite considerable effort over the past two decades, rapid and specific detection of pathogenic Campylobacter is still difficult. Current detection methodology requires significant resources and time in a modern clinical laboratory. This application proposes the development of a reagent kit that would be used for the rapid and accurate detection of pathogenic Campylobacter spp. using readily available reagents and hardware.

PHASE I: To develop a simple, rapid system to detect Campylobacter spp. in fecal samples using an antibody immunoassay to concentrate this bacteria and PCR to amplify Campylobacter-specific sequences to permit detection in less than 12 hours. This system would be based on the use of antibodies to specifically 'capture' Campylobacter spp. from raw samples, then detect specific DNA sequences using PCR.

PHASE II: The detection system will be tested at a pediatric diarrhea vaccine site located near Alexandria, Egypt to determine utility under field conditions and will be adapted to allow the processing of multiple samples.

PHASE III: Upon successful field testing, a reagent kit that is compatible with existing commercial hardware would be developed, permitting widespread use of the detection system in both the military and civilian sectors.

COMMERCIAL POTENTIAL: This product would have the greatest commercial potential both in the health-care and agricultural industry. Campylobacter infections in humans and in poultry are still difficult and time-consuming to detect, even in the best clinical laboratories. Development and marketing of this system would give, for the first time, a simple, rapid, and cost-effective procedure to detect Campylobacter spp. in large numbers of samples.

REFERENCES:
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and W.G. Quint. Development of species-specific DNA probes for Campylobacter jejuni, Campylobacter coli, and Campylobacter lari by polymerase chain reaction fingerprinting. J. Clin.Microbiol. 1993: 31(6):1541-1546.
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BUREAU OF NAVAL PERSONNEL

N96-137 TITLE: Determining the Optimal Mix of Manpower.

OBJECTIVE: Develop new methodology to determine the optimal mix of manpower skills and pay levels.

DESCRIPTION: As the Navy's drawdown continues, it must greatly reduce the number of shore military manpower spaces. In 1970, 70% of all Navy officers were unrestricted line (URL). Today, only 48% are URL officers. During the force build-up in the 1980s much of the growth in officers was in the restricted line (RL) and staff corps (STAFF). During the early years of the current drawdown, some officer communities (e.g. medical) were exempt from reductions. As a result, the URL, which includes the Navy's primary warfighting communities (surface warfare, submarine warfare, aviation warfare, etc.) has absorbed a disproportionate share of officer reductions. This has greatly reduced career advancement and shore rotation opportunities for these communities.

PHASE I: Design a methodology to determine the optimal mix of manpower skills and pay levels using Navy officer communities and enlisted ratings as the test bed. Ensure that the procedure provides for reasonable shore rotation opportunities and equitable career advancement.

PHASE II: Develop, test, and operationally demonstrate the model(s) designed under Phase I.

PHASE III: Produce a version of the model marketable in the civilian sector.

COMMERCIAL POTENTIAL: Any industry with an interest in "right sizing" while maintaining career advancement opportunities and an optimal workforce mix (in terms of skills, experience and pay levels) would benefit from the product of this effort.

N96-138 TITLE: Determining the Size and Relative Efficiency of Corporate Infrastructure.

OBJECTIVE: Develop a new methodology to (1) link reductions in primary product to infrastructure reductions and infrastructure efficiency and (2) link infrastructure manpower needs to aggregate budget variables.

DESCRIPTION: The Navy defines Manpower in four broad categories: Battle Forces, Battle Force Support, Other Support, and the Individuals Account. Navy manpower reductions from fiscal year 1989 through fiscal year 1995 will reduce Battle Forces by 31% and Other Support by 18%. Some areas in Other Support are actually growing, e.g., environmental programs and defense agencies. Some of the hardest choices the Navy must make in the next several years are where to reduce Other Support manpower. Recent CNO guidance requires that resource sponsors make greater end strength reductions from infrastructure and support (Other Support). However, ownership of these activities is often split among resource and program sponsors. This can lead to duplication of functions across activities, often in the same geographic area. Also, because ownership is split, it is difficult to directly relate infrastructure reductions to reduction in the primary product (Battle Forces), e.g. what support is related to the decommissioning of an A-6 aircraft squadron.

PHASE I: Design a methodology to (1) link reductions in the primary product to infrastructure reductions and infrastructure efficiency, (2) link infrastructure manpower needs to aggregate budget variables, and (3) determine infrastructure inefficiencies, duplication of functions and potential for reduction or consolidation.

PHASE II: Develop, test, and operationally demonstrate the models designed under the Phase I effort.

PHASE III: Produce a version of the model marketable in the civilian sector.

COMMERCIAL POTENTIAL: Workforce management in the private sector could benefit from the methods of "right sizing" demonstrated in this effort. Any industry with an interest in defining duplication of functions, inefficiencies, and potential for

reduction would benefit from this effort.

NAVAL FACILITIES ENGINEERING CENTER

N96-139 TITLE: Measurement of the Extent of Deterioration of Concrete in Reinforced Concrete Structures

OBJECTIVE: Develop non-destructive methods to quantitatively locate and size the extent of concrete deterioration in Navy reinforced concrete structures.

DESCRIPTION: Develop a portable hand-held nondestructive inspection tool to measure the depth and areal extent of concrete deterioration in reinforced concrete structures.

PHASE I: The contractor shall explore non-destructive techniques and tools that may satisfy the objectives of detecting the depth and areal extent of deteriorated concrete. Demonstrate proof of concept via laboratory testing for candidate system(s).

PHASE II: Develop and construct prototypes tools. Test prototype inspection tools in field-like applications for their accuracy, precision, accessibility and ease of operation. Complete a failure mode and effect analysis of the design, manufacturing and operational process associated with each inspection tool. Prepare a final report of the findings and make recommendation for preparing the tools for field use. Phase II funding will depend on the availability of advanced development funding, along with contractor's investment strategy and product development plan.

PHASE III: Construct a actual inspection tool for commercial use.

COMMERCIAL POTENTIAL: The results of this development will provide the commercial sector with an easy and cost effective method to locate areas of concrete deterioration in all types of reinforced concrete structures: piers, wharfs and buildings.

REFERENCES: US Dept Transportation: Conference on Nondestructive Evaluation of Bridges, 1992

N96-140 TITLE: Tag Initiated Communications System for Real Time Asset Monitoring

OBJECTIVE: The objective is to develop a method to implement tag initiated communications in an asset management system. The protocol will retain all the advantages of the current system while allowing add-on module (temperature sensor, etc.) alarm condition to be immediately reported to the PC network.

DESCRIPTION: Develop communications hardware and firmware that will enable a tag to establish RF communication (tag initiated) with an interrogator of its own volition. Specific problems to be resolved will be the protocol to handle the communications, management of tag battery life in situations where the tag's request for communication goes unheeded and design of a multi-tasking interrogator accepting simultaneous inputs from both the PC network and multiple tags. Develop system enhancements to allow real time monitoring of a local area or portal without reducing tag battery life.

PHASE I: The first portion of the work will be to define the protocol for tag initiated communication. The tag will need a system for processing external interrupts originating from the add-on module and determining the proper routing. A method of checking the airwaves for existing RF communication will be researched to avoid RF interference and the resulting collisions. If the airwaves are clear, the tag will transmit the interrupt or data to the interrogator via it current RF transmitter. The protocol must address instances in which the tag is outside of the interrogator range or the interrogator is busy and the tag does not receive a response from the interrogator. The interrupt event must be stored in the tag memory for future retrieval and the battery cannot be drained by repeated communication attempts.

PHASE II: The contractor shall prepare a brass-board concept feasibility model and demonstration. It shall demonstrate open RF transmission protocols between tags and interrogators, and remote heads-up displays. Volume data handling will be demonstrated.

PHASE III: The contractor shall prepare a system for suitable testing on a large scale. Transmission protocols will communicate with tens to thousands of tags present within range, while interfacing the information to a variety of identified military systems. Transition will include commercially available system integration components.

COMMERCIAL POTENTIAL: The RF tag which interfaces to large information volume applications will be a benefit to the medical, manufacturing, transportation, and maintenance fields. Item control within wireless local and wide area networks will

greatly increase the user ability. Tags will be compatible with the National Information Infrastructure initiatives.

REFERENCES: MIL-STDs 1780, 81, 82; FIPS PUB 1461-1; RFCs 822, 1122, 23

N96-141 TITLE: Geomorphic Site Selection Software Tool

OBJECTIVE: Develop a combined database and analytic model which can predict the likelihood of sediment type and depth at a specified location on any coastline in the world, given the geographic location and certain geomorphic and oceanographic data about the site. This data is readily available through satellite imagery.

DESCRIPTION: The model will generate statistics regarding sediment properties by correlating the observable land form and ocean pattern data to likely sediment characteristics. Regional historic data , when available, and geologic theory correlating geologic provinces to plate tectonics will supplement and validate the model's predictions.The tool will most importantly provide the means for selecting suitable sites with more confidence than is currently possible today. Use of the model will expand the range of potential operations sites for planners by providing statistical information for those locations for which no specific geotechnical or geophysical data is available. The tool also will provide valuable information regarding the likelihood of foundation problems that may be encountered at specific sites, enabling the development of operations plans for overcoming those obstacles. The tool could also be expanded to predict shoaling conditions for specific sea states if adequate hydrographic and oceanographic data is available for the site.

PHASE I: Conduct a feasibility study of the proposed site selection tool. The study shall include an assessment of existing satellite imagery and its applicability to this task, and an analysis of the statistical viability of using the tool to estimate sediment type and depth at coastal locations across the world. Demonstrate proof of concept.

PHASE II: Develop prototype system and participate in field tests of the unit. Develop commercial linkages to the offshore and geotechnical industries.

PHASE III: Refine and implement the prototype system. Transition the system to the Navy, to CNO N85.

COMMERCIAL POTENTIAL: The system could be useful to offshore design and construction firms who need preliminary sediment data prior to conducting on-site investigations.

N96-142 TITLE: Integrated Hydrographic, Geophysical, Geotechnical and Oceanographic Data Collection Sensors

OBJECTIVE: Develop a standard open architecture network for integration of hydrographic, geophysical, geotechnical and oceanographic data collection sensors using a real-time, multi-tasking, multi-processor operating system running a "survey executive" and operating a network of "sensor engines". This concept will allow the control of a diverse set of sensors which can be used in the search, survey, classification and localization of small metal objects in the nearshore ocean environment. Each sensor(s) hardware/software will be a processing task (sensor engine) on the network.

DESCRIPTION: The state of practice in offshore surveying involves assembling a suite of sensor, from various manufacturers, integrating them as much as possible and conducting field operations. Upon completion of the field operations the data, some in digital form, some hard copy, is assembled and interpreted. The suite is highly sub-optimal. For instance, the fathometer's signal, shows up as noise on the side scan sonar and also interferes with the acoustic navigation system. This sub-optimization of system occurs because each manufacturer has optimized their system. Such a suite may have Differential Global Position Satellite navigation with an accuracy of $\pm$ 3 meters that updates every second, but the vessel is traveling at 3 kts (1.54 m/s), thus a position update every 2 seconds is adequate. It could have an ultra short baseline acoustic system to monitor the position of the side scan sonar towfish, updating every 1 second. These are optimal systems, each is performing at it best repetition rate, but as a system they would provide better data if the DGPS updated every two seconds and immediately after an update was received the USBL system updated the towfish position. The USBL - fathometer interference could be eliminated if the fathometer was shut down for the time required to take the USBL fix. The fathometer - side scan sonar interference could be eliminated if the fathometer repetition rate was adjusted and data was logged when needed not a the fastest rate possible.The state of technology has advanced to the point that this sub-optimization can be overcome. Each of these sensor systems can be viewed as a transducer with signal processing. Thus it is possible to integrate all of these systems on a single open-architecture, multi-processor, multi-tasking computer network linked together by a "survey executive" and operate the diverse sub-system in an optimal manner. To achieve this system optimization each system in the current survey suite can be replicated in software, using industry standard computers and digital signal processing interface cards. Using system analysis techniques each system

can be reduced to a series of inputs and outputs, which are quite generic. With the proper definition of inputs and outputs it possible to consider a *sensor engine* running in software, interfacing with other programs via the network and connected to external transducers. This leads to a network of computers, each one replacing a previous hardware system.

PHASE I: Select the operating system, conduct the system analysis, determine if sufficient processing power is available, and fabricate a test bed system with a navigation engine (DGPS input) running in hardware/software and a preliminary survey executive running.

PHASE II: Validate the effort by adding a USBL sensor engine and a side scan sonar sensor engine.

PHASE III: Transition to O&M funding by a Navy Engineering Field Division. Implement a business plan and a commercial investment strategy for marketing the system.

COMMERCIAL POTENTIAL: The commercial potential is high, the contractor will be encouraged to interface with standards organizations such as National Marine Electronics Association and other government sponsored industry groups such as the Marine Mineral Technology Centers to create a commercial standard.

N96-143 TITLE: Very Low Cost Miniature Radio Tag with ASIC Architecture

OBJECTIVE: The objective is to develop a small, low cost heterodyne RF transceiver. The transceiver will use ASIC designs for RF and analog circuits.

DESCRIPTION: The principle components of current high technology, state-of-the- art Radio Frequency Identification (RFID) equipment designed for asset management and inventory are the tags and the interrogators. These incorporate extremely sensitive RF transceivers and communicate using Batch Collection®, a proprietary communication protocol. Although effective, these components use discrete elements in their construction, resulting in a high cost for the tags. This high cost limits potential applications, even when technical performance is acceptable. The most revolutionary changes in cost and size will be realized only with an Application Specific Integrated Circuit (ASIC) for the RF circuitry. An ASIC based tag will reduce size and cost to provide lower end item cost visibility. Careful attention to the ASIC design will also allow use in the interrogators to reduce their cost and provide very small portable interrogators.

PHASE I: The current discrete technology consists of an UHF FM transmitter and superhetrodyne receiver. The primary objective is selection of an ASIC technology and architecture with performance similar to the current technology embodiment. The preferred ASIC would use the same transceiver architecture, but a thorough technical specific research program will be necessary to determine if the current architecture is suitable for an ASIC. The research program should result in a clear ASIC development path which is ready for a Non-Recoverable Engineering (NRE) contract with the ASIC design company.

PHASE II: The Phase I investigation will provide the information and test strategy that will be used to develop and demonstrate the ASIC design.

PHASE III: The contractor shall prepare a system for suitable testing on a large scale. Transmission protocols will communicate with tens to thousands of tags present within range, while interfacing the information to a variety of identified military systems. Transition will include commercially available system integration components.

COMMERCIAL POTENTIAL: The availability of a highly cost effective tag, made possible by the ASIC, will greatly expand the applications to which the tag may be suitable by reducing cost and size. In the private sector, particularly the warehousing and transportation industries, the use of ASIC design will expand the use of the tag by allowing its use on relatively inexpensive end items. A reduced size tag will allow mounting on smaller or irregular shaped items which present mounting difficulties for the present designs.

REFERENCES: MIL-STDs 1780, 81, 82; FIPS PUB 1461-1; RFCs 822, 1122, 23

AIR FORCE
PROPOSAL PREPARATION INSTRUCTIONS

The responsibility for the implementation and management of the Air Force SBIR Program is with the Air Force Materiel Command, Wright-Patterson Air Force Base, Ohio. The Air Force SBIR Program Executive is R. Jill Dickman, (800) 222-0336. Do NOT submit SBIR proposals to the AF SBIR Program Executive under any circumstances. Addresses for proposal submission and numbers for administrative and contracting questions are listed on the following pages, AF-2 thru 4.

Technical questions may be requested using the DTIC SBIR Interactive Technical Information System (SITIS). For a full description of this system and other technical information assistance available from DTIC, please refer to section 7.1 on page 12 of this solicitation.

The Air Force intends to extend the Phase I period of performance on a trial basis by three (3) months (from six to nine months) when required by agency needs or reseaqrch plans. Therefore, if the firm judges that the nine-month period of performance would be important in meeting AF needs or research plans, the firms are encouraged to submit their Phase I proposal based on the following elements:

a. The total period of performance for Phase I is nine (9) months.

b. The required contract structure and deliverables are as follows:

Item	Description	Period of Performance	Deliverable
0001	Research	Six (6) months	Draft Final Technical Report
0002	Research	Three (3) months	Final Technical Report

c. Price:

(1) The total price of Item 0001 shall not exceed $80,000.
(2) The total price of Item 0002 shall not exceed $20,000.

d. Item 0001: Research or research and development as defined for Phase I in paragraph 1.2 of the solicitation.

e. Item 0002: Firms must refine their research or research and development conducted under Item 0001 and submit a comprehensive and Final Technical Report covering the total Phase I period of performance.

f. It is the Air Force intent to invite submission of Phase II proposals on or before completion of Item 0001.

Firms not interested in the above scenario may submit a proposal not to exceed $80,000 based on the requirements contained in the solicitation:

Item	Description	Period of Performance	Deliverable
0001	Research	Six (6) months	Final Technical Report

PROPOSAL SUBMISSION INSTRUCTIONS

For each Phase I proposal, send one original and three (3) copies to the office designated below. Be advised that any overnight delivery may not reach the appropriate desk within one day.

TOPIC NUMBER	ACTIVITY/MAILING ADDRESS	CONTRACTING AUTHORITY
	(Name and number for mailing proposals and for administrative questions)	(For contract questions only)
AF96-001 thru AF96-004	Air Force Office of Scientific Research AFOSR/XPP (John Colon) 110 Duncan Avenue, Suite B115 Bolling AFB DC 20332-0001 (John Colon, (202) 767-7756)	Ernest Zinser (202) 767-4992
AF96-005 thru AF96-028	Armstrong Laboratory AL/XPTT 2509 Kennedy Circle Brooks AFB TX 78235-5118 (Belva Williams, (210) 536-2103)	Sharon Shen (210) 536-6393
AF96-029 thru AF96-060	Rome Laboratory RL/XPX 26 Electronic Parkway Griffis AFB NY 13441-4514 (William Gregory, (315) 330-3046)	Joetta Bernhard (315) 330-2308
AF96-061 thru AF96-081	Space & Missiles Technology Phillips Laboratory/XPI SBIR Program (R. Hancock) 3650 Aberdeen Ave SE Kirtland AFB, NM 87117-5776 (Mr. Robert Hancock, (505) 846-4418)	Mr. Francisco Tapia (505) 846-5021
AF96-082 thru AF96-084	Advanced Weapons & Survivability Phillips Laboratory/XPI SBIR Program (R. Hancock) 3650 Aberdeen Ave SE Kirtland AFB, NM 87117-5776 (Mr. Robert Hancock, (505) 846-4418)	Mr. Francisco Tapia (505) 846-5021

AF96-085 thru AF96-094	Propulsion OL-AC Phillips Laboratory/RKTC SBIR Program (S. Borowiak) 4 Pollux Dr. Edwards AFB, CA 93524-7730 (Ms. Sandra Borowiak, (805) 277-3900 X2229)	Ms Liliana Milhaleski (805) 277-3900 X2229
AF96-095 thru AF96-100	Geophysics OL-AA Phillips Laboratory/XPG SBIR Program (N.Dimond) 29 Randolph Rd, Bldg 1107, Rm 240 Hanscom AFB, MA 01731-3010 (Ms Noreen Dimond, (617) 377-3608)	Mr. John Flaherty (617) 377-2529
AF96-101 thru AF96-111	Lasers & Imaging Phillips Laboratory/XPI SBIR Program (R. Hancock) 3650 Aberdeen Ave NE Kirtland AFB, NM 87117-5776 (Mr. Robert Hancock, (505) 846-4418)	Mr. Francisco Tapia (505) 846-5201
AF96-112 thru AF96-113	Space Experiments Phillips Laboratory/XPI SBIR Program (R. Hancock) 3650 Aberdeen Ave SE Kirtland AFB, NM 87117-5776 (Mr. Robert Hancock, (505) 846-4418)	Mr. Fransisco Tapia (505) 846-5201
AF96-114 thru AF96-126	WL/AAOP, BLDG 624 2nd Floor ATTN: Sharon Gibbons 2011 8th Street, Room N2G21 Wright-Patterson AFB, OH 45433-7623 (Sharon Gibbons, (513) 255-5285)	Terry Rogers (513) 255-5830 Bruce Miller (513) 255-7143
AF96-127 thru AF96-134	WL/ELA, BLDG 620 2241 Avionics Circle Ste 29 Wright-Patterson AFB, OH 45433-7331 (Howard Romaker, (513) 255-6723)	Terry Rogers (513) 255-5830 Bruce Miller (513) 255-7143
AF96-135 thru AF96-146	Wright Laboratory Flight Dynamics Directorate WL/FIOP, BLDG 45 Wright-Patterson AFB, OH 45433-7542 (Madie Tillman, (513) 255-5066)	Terry Rogers (513) 255-5830 Bruce Miller (513) 255-7143

AF96-147 thru AF96-161	WL/MLIP, BLDG 653 2977 P St, Ste 13 Wright-Patterson AFB, OH 45433-6523 (Sharon Starr, (513) 255-7175)	Terry Rogers (513) 255-5830 Bruce Miller (513) 255-7143
AF96-162 thru AF96-176	WL/POM, BLDG 18 1950 Fifth St, Room 105A Wright-Patterson AFB, OH 45433-7251 (Betty Siferd, (513) 255-2131)	Terry Rogers (513) 255-5830 Bruce Miller (513) 255-7143
AF96-177 thru AF96-180	WL/MTX, BLDG 653 2977 P St, Ste 6 Wright-Patterson AFB, OH 45433-7739 (Marvin Gale, (513) 255-4623)	Terry Rogers (513) 255-5830 Bruce Miller (513) 255-7143
AF96-181 thru AF96-182	ASC/XRP, BLDG 56 2100 Third St, Ste 2 Wright-Patterson AFB, OH 45433-7016 (Fred Strawn, (513) 255-6673)	Arnette Long (513) 255-6134
AF96-183 thru AF96-198	Armament Directorate WL/MNPB 101 West Eglin Blvd, Suite 143 Eglin AFB, FL 32542 (Richard Bixby, (904) 882-8591)	Lyle Crews, Jr (904) 882-4284
AF96-199 thru AF96-228	AFMC-TTO/TTP, BLDG 22 2690 C St, Ste 5 Wright-Patterson AFB, OH 45433-7412 (Rebecca Holbrook, (513) 255-3442)	

AIR FORCE 96.1 KEYWORD INDEX

AIR FORCE 96.1 TOPIC INDEX

AF96-026	Chemical/Biological Warfare Defense Detection and Decontamination Technology
AF96-027	Development of Easy Application Skin Biopotential Electrode
AF96-028	Head-Mounted Thermal Imager
	ROME LABORATORY, GRIFFISS AFB NY
AF96-029	C4I Systems/Subsystems
AF96-030	Automatic Agent/Expert Technology Algorithms
AF96-031	Passive Tracking of Airborne Targets
AF96-032	Broadcast and Internet Link Security Measures
AF96-033	Innovative C3I Technologies
AF96-034	Intelligent Software for Information Architectures
AF96-035	Intelligent Systems Technology Development
AF96-036	C3I Parallel Software Template System
AF96-037	Integrated Performance Support for Task Automation (IPSTA)
AF96-038	Transformational Mapping of Formal Specifications onto Parallel Architectures
AF96-039	Testable Die Carriers
AF96-040	Testability Insertion For Commercial Off-The-Shelf Parts
AF96-041	A Specification Interface for VHSIC Hardware Description Language (VHDL) Designs
AF96-042	Passive Electrostatic Discharge Detector for Integrated Circuits
AF96-043	Integrated Physical Modeling and Analysis of Microelectronics
AF96-044	Development of Time-Domain Planar Near-Field Scanning Measurement Techniques
AF96-045	Integrated Magneto-Optical Thin Films for Indium Phosphide (InP) Optoelectronic Integrated Circuits (OEICs)
AF96-046	Integrated Surface-Normal Optical Fiber Positioning for Indium Phosphide (InP) Optoelectronic Integrated Circuits (OEICs)
AF96-047	Millimeterwave Components for C3 and improved noise models for CAD
AF96-048	Infrared Imaging Spectrometer
AF96-049	Multifunction Phased Arrays
AF96-050	Optoelectronic Silicon Quantum Wells With High Barriers
AF96-051	Optically Addressed Spatial Light Modulator with Dual Input Subtraction Capability

AF96-052	Optical Data Storage and Retrieval
AF96-053	Automated Imagery Exploitation
AF96-054	Intelligent Desktop Computer Assistant
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AF96-057	Operations Other Than Warfare
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AF96-062	Radiation Protective Composite Spacecraft Structures
AF96-063	Innovative Technologies for Space Extremely High Frequency (EHF) Communications System
AF96-064	New Infrared Focal Plane Array Concepts
AF96-065	Anomaly Resolution Using Case-Based and/or Model-Based Reasoning
AF96-066	Enhancing Satellite Operations Through Increased Space Automation
AF96-067	Space Power Components
AF96-068	High Power Density Electronics Thermal Control
AF96-069	Radiation-Tolerant Microelectronic Device Development
AF96-070	Space-Qualifiable, Non-Hermetic Packaging
AF96-071	Advanced Spacecraft Mechanisms
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AF96-073	Lightweight, Magnetic Suspended Reaction Wheels
AF96-074	Launch Isolation System for Reusable Launch Vehicle Containerized Payload Systems
AF96-075	Thermally Conductive Vibration Isolation System for Cryocoolers
AF96-076	Attenuation of Acoustic Disturbances in Expendable Launch Vehicle Payload Fairings
AF96-077	Distributed Object Management Environment for Improving Space Mission Fault Tolerance
AF96-078	Resettable, Lightweight Bypass Switch for Battery Cells

AF96-079	Smart/Adaptive Structures using Thin-Film Shape Memory Alloys
AF96-080	Metal Matrix Joining Techniques
AF96-081	Telemetry Front-End Using PC-Based Systems
	PHILLIPS LABORATORY - ADVANCED WEAPONS & SURVIVABILITY, KIRTLAND AFB NM
AF96-082	Electromagnetic Effects, Measurements, Protection, Sources, and Satellite Protection
AF96-083	Biomedical Engineering Applications of Microwave Technology
AF96-084	Analog Fiber-Optic Link With 10 GHz Bandwidth
	PHILLIPS LABORATORY - PROPULSION, EDWARDS AFB CA
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AF96-086	Electro-Optic Devices for Rapid and/or In-situ Combustion Measurements
AF96-087	Electric propulsion thruster for low power small satellites
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AF96-096	Optical Sensors for Geophysical Remote Sensing, Environmental Monitoring and Target Characterization
AF96-097	Tunable UV Dial Lidar
AF96-098	Portable Remote Wind Sensing Lidar
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	PHILLIPS LABORATORY - LASERS & IMAGING, KIRTLAND AFB NM
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AF96-102	Technology Transfer/Dual Use - Medical or Industrial Applications of Laser Technology

AF96-103 Micro Mechanical Adaptive Optics System

AF96-104 Development of High Power 1.5 to 1.8 Microns Semiconductor Lasers

AF96-105 Compact Coupling of High-Power Semiconductor Lasers into Single-Mode Fibers

AF96-106 Continuous Tunable Laser Sources for the 3-5 and 7-14 Micron Regions

AF96-107 Semiconductor Lasers Optical Pump Sources to Generate Mid-IR or UV-vis Radiation

AF96-108 High-Power, Coherent InGaAsP Semiconductor Lasers or Amplifiers

AF96-109 Long Range Imaging and Sensing

AF96-110 Multi-Function Coatings for the Space Environment

AF96-111 Advanced Clutter Suppression Techniques for Space Based Infrared Sensors

PHILLIPS LABORATORY - SPACE EXPERIMENTS, KIRTLAND AFB NM

AF96-112 Space or Near Space Flight Experiments Demonstration Support

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WRIGHT LABORATORY - AVIONICS DIRECTORATE, WRIGHT-PATTERSON AFB OH

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AF96-116 Avionics Sensor Development

AF96-117 Avionics Simulation Development

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AF96-121 Multi-Spectral Fusion Techniques

AF96-122 Airborne Radar Technology

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AF96-124 Instrumentation for Digital Radio Frequency Memory (DRFM) Research

AF96-125 Tagging Acquisition Mode Radar Signals for Countermeasures

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WRIGHT LABORATORY - SOLID STATE ELECTRONICS DIRECTORATE, WRIGHT-PATTERSON AFB OH

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AF96-128	Environmentally Safe-Solvent Cleaning Technique for Wafer Cleaning
AF96-129	Rapid Whole-Wafer Carrier Concentration and Dislocation Density Measurement
AF96-130	In Situ Monitor for Advanced III-V Molecular Beam Epitaxy (MBE) Control
AF96-131	Electronic Design Automation
AF96-132	Innovative Microelectronics Device Development
AF96-133	Broadband Tunable Lasers for Multiplexing/Demultiplexing Fiber-Optic Sensors
AF96-134	Modeling and Simulation of Monolithic Microwave Integrated Circuits (MMICs) and Interconnects in Microwave Packages

WRIGHT LABORATORY - FLIGHT DYNAMICS DIRECTORATE, WRIGHT-PATTERSON AFB OH

AF96-135	Advanced Structural Concepts
AF96-136	Advanced Design Methods for Aircraft Structural Technology Integration
AF96-137	Flight Control Technology and Integration
AF96-138	Engineering Research Flight Simulation Technologies
AF96-139	Aeromechanics Technology for Advanced Flight Vehicles
AF96-140	Development of an Expert System for Computational Fluid Dynamics
AF96-141	Aircraft Wake Turbulence Sensor
AF96-142	An Adaptive, Real-Time Situation Assessor for Advanced Cockpits
AF96-143	Laser-Specific Vision Protection for Pilots Without Implicating Existing Cockpit Optical Parameters
AF96-144	Fire Suppression and Surveillance
AF96-145	Nondestructive Residual Stress Measurements in Aircraft Wheels
AF96-146	Target Discrimination for Subsurface Ordnance Characterization

WRIGHT LABORATORY - MATERIALS LABORATORY, WRIGHT-PATTERSON AFB OH

AF96-147	Carbon-Carbon for Improved Environmental Quality
AF96-148	Electrically or Thermally Conductive Resins for Composite Structures for Space Applications
AF96-149	Switchable Thermal Control Coatings
AF96-150	3-D Boundary Element Analysis for Composite Joints with Discrete Damage
AF96-151	Development of Novel Electro-Optic Materials for Advanced Aircraft Avionics Systems
AF96-152	Automated Data Acquisition for In-Situ Material-Process Modeling
AF96-153	Nondestructive Evaluation/Characterization

AF96-154 Metallic Structural Materials for Air Force Systems

AF96-155 High Temperature Structural Materials for Advanced Air Force Systems

AF96-156 Advanced Infrared Optical Materials

AF96-157 Nonlinear Optical Materials

AF96-158 Epitaxial Growth of Silicon Carbide (SiC)

AF96-159 High Temperature Superconducting Thin Films

AF96-160 Electromagnetic Fire Suppression

AF96-161 Biodegradable, Direct Replacement Hydraulic Fluids for MIL-H-5606 and MIL-H-83282

WRIGHT LABORATORY - AERO PROPULSION AND POWER DIRECTORATE, WRIGHT-PATTERSON AFB OH

AF96-162 Aero Propulsion & Power Technology

AF96-163 Aircraft Electrical Power System Technologies for Existing Air Force Aircraft

AF96-164 High Temperature, High Power Electrical Component Development

AF96-165 Cooling of Aircraft Components

AF96-166 Cryogenic Power Converter

AF96-167 High Mach Combined Cycle Engine Technology

AF96-168 Diagnostics Development for Supersonic Combusting Flows

AF96-169 Environmentally Benign Aviation Lubricants

AF96-170 Laser Diagnostics for Characterization of Practical Combustor Hardware

AF96-171 Hybrid Magnetic/Gas/Rolling-Element-Bearing Rotor Support System

AF96-172 Compression System Design Methodology

AF96-173 Aircraft Turbine Component Technology - Aerodynamics and Cooling

AF96-174 Probabilistic Methods for Structural Management of Gas Turbine Engines

AF96-175 Sensing Surface Temperatures of Ceramic Matrix Composites (CMC) Materials

AF96-176 Hypervelocity Vehicle Technology

WRIGHT LABORATORY - MANUFACTURING TECHNOLOGY DIRECTORATE, WRIGHT-PATTERSON AFB OH

AF96-177 Joining Methods for Organic Matrix Composites

AF96-178 Create a Process Analysis Tool Kit for Affordability (PATA) Supporting the R&D Process

AF96-179	Development of Affordable Integrated Optic Chips
AF96-180	High Temperature Bagging and Sealant Materials for Composite Manufacture
	WRIGHT LABORATORY - AERONAUTICAL SYSTEMS CENTER, WRIGHT-PATTERSON AFB OH
AF96-181	Automated Methodology for Integrating Cost with Operational Effectiveness Analyses
AF96-182	Architecture and Tools for Processing Pre-Award Systems Acquisition Documents
	WRIGHT LABORATORY - ARMAMENT DIRECTORATE, EGLIN AFB FL
AF96-183	Armament Research
AF96-184	Endo Atmospheric Hypersonic Vehicle Technology
AF96-185	Miniaturized GPS Antenna Array Interference Resistance Concepts
AF96-186	Optical Detection and Discrimination Techniques for Laser Radar
AF96-187	Active Infrared Optical Component Development
AF96-188	Alternative Passive Millimeter-Wave Imaging Camera
AF96-189	Laser Scanning Techniques
AF96-190	High Density Shock Survivable Microelectronics
AF96-191	Miniature Pulsed Power Generators
AF96-192	Solid State Accelerometer
AF96-193	Low-Cost Compact Ultra-Fast Electromagnetic Sampler
AF96-194	Low Cost, High Power Solid State Switch
AF96-195	Detection, Analysis and Reuse of Waste Streams Generated by Energetic Materials
AF96-196	Nonlinear Estimators for Transfer Alignment/Navigation
AF96-197	Advanced Techniques for Arena Testing & Image Motion Modeling/Reconstruction
AF96-198	Predicting Chemical/Biological Agent Release from Fixed Ground Structures
	TECHNOLOGY TRANSITION OFFICE, WRIGHT-PATTERSON AFB OH
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AF96-200	Stick and Peel Adhesive
AF96-201	Calibrated Infrared (IR) Focal Plane Array (FPA) Imagers
AF96-202	Arena Test Fragment Field Evaluator
AF96-203	Water Impact Scoring

AF96-204	Multiple Direction Blast Pressure Measurement
AF96-205	Ultrasound for circuit card diagnostics
AF96-206	Filmless Radiography
AF96-207	Repair tracking system
AF96-208	High Strength Aircraft Quality Bolts Manufactured From Smart Materials
AF96-209	Early Warning Aircraft Damage Detection
AF96-210	Tomographic Image Analysis Software
AF96-211	Prediction of Remaining Useful Life of Aircraft Components Using Non-Destructive Inspection (NDI) Data
AF96-212	Improved Flush Fastener Technology
AF96-213	Fractal Applications for Simulation Environments
AF96-214	Low Cost Curing and Repair Process for Composites
AF96-215	Portable Large Area Rapid Scan Nondestructive Inspection (NDI) for Composite Components
AF96-216	Thermal Fuel Tank Leak Detection Device
AF96-217	Low Cost, Calibrated, Portable, computer Controlled Variable Output IR/UV Source
AF96-218	Airborne Data Recorder
AF96-219	Avionics Bus Data Compression
AF96-220	Optimal Utilization of Telemetry Spectrum
AF96-221	Universal Programmable (Computer to IR Sensor) Interface - UPI
AF96-222	Automated Anechoic Chamber Electromagnetic Field Probe
AF96-223	Expanded Polystyrene (EPS) Foam Column Research
AF96-224	Remote Operation of a Carrier Phase Receiver
AF96-225	Non-intrusive Surface Mapping of Ice Contaminated Aero-surfaces
AF96-226	Wind Tunnel Bearing/Balance Test Mechanism for Performing Virtual Flight Testing (VFT)
AF96-227	6-DOF Angular Acceleration Calibration Device for Subscale Ground Testing
AF96-228	Vibration Analysis of Rotating Plant Machinery

AIR FORCE 96.1 TOPIC DESCRIPTIONS

AF96-001 TITLE: Thermal-Barrier and Corrosion-Protective Nano- and Micro-Laminated Ceramic Coatings

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop technology for economical fabrication of nano- and micro-laminated ceramic coatings for thermal, mechanical, and environmental protection of metals.

DESCRIPTION: Currently, there is great interest in the mechanical and thermal properties of ultra-fine scale laminated ceramic coatings. Structural applications of such coatings include thermal barriers, environmental-protective barriers, and graded mechanical interstructural multilayers. Thermal and environmental barriers are of particular interest to both aircraft gas turbines and land-based power generating units. Their primary function is to allow an increase in combustion temperature of structural metallic components. Coated components often include: combustion liners, transition pieces, nozzles, and turbine blades. Oxide nano-layered ceramic coatings are of particular promise in these applications due to their inherent stability in oxidizing environments. In addition to the engine-related applications, some nano-layered ceramic coatings, particularly of nitride family, have shown excellent mechanical properties, such as very high hardness and wear resistance. These properties make the nano-layered ceramic coatings attractive for protecting metal surfaces in bearings and other wear-intensive applications. A major objective of this program is to develop nano- and micro-laminated ceramic coatings on structural metals. These new technologies should result in apparent and substantial gains in performance of propulsion- and wear-related structural parts and should lead to substantial savings for the Air Force in the near future.

PHASE I: Identify a particular application where nano- or micro-laminated ceramic films might have a major impact on a particular Air Force program. Conduct preliminary experiments to show feasibility of selected ceramic system and manufacturing process. Establish a strong contact with a related agency at Wright Laboratory, Wright-Patterson Air Force Base.

PHASE II: Fabricate an agreed number of prototypes of selected parts and deliver them for testing to the Air Force and/or an Air Force contractor.

POTENTIAL COMMERCIAL MARKET: The technologies developed under this program are expected to have a major impact on both military and commercial engines, including air-breathing propulsion, power generation, and civilian vehicles.

AF96-002 TITLE: Software for Computational Chemistry

CATEGORY: Basic Research
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Development of software tools for use in computational chemistry and molecular simulations.

DESCRIPTION: Computational chemistry has become a valuable tool in many Air Force efforts. Computational chemistry methods have been applied to issues involving, but not limited to, the calculation and visualization of molecular structures and spectra, the assessment of chemical reactivity and molecular properties, and the simulation of solvation, molecular interactions, and materials properties. Systems of interest span the gas phase and condensed phases. Advances in high performance computing and graphical interfaces have enabled new problems to be addressed by computational chemistry. These developments have also created needs for new software tools to exploit the state-of-the-art capabilities of high performance computers and parallel architectures. Integration of a range of computational chemistry tools into easily accessible formats can also enable more facile application of these methods to a wide range of chemical problems. We seek the development of software that will provide new capabilities for computational chemistry that will enable the improved prediction and simulation of properties and processes in molecules and materials.

PHASE I: Demonstrate the feasibility and effectiveness of the computational approach and system design.

PHASE II: Produce a prototype implementation that would allow the concept to be demonstrated and explored in a laboratory or user environment.

POTENTIAL COMMERCIAL MARKET: Computational chemistry software has broad utility throughout the scientific community and has a wide range of potential applications in industry. Computational chemistry is used extensively to predict

molecular structure and select molecules for possible development, particularly in the pharmaceutical industry. Software for the efficient and effective prediction of molecular and materials properties will also be of great use to many US industries to reduce development costs and to access potential benefits or hazards of materials.

AF96-003 TITLE: Focused Applications Software For Design of Ferrite Patch Antennas

CATEGORY: Basic Research
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop a computer code to aid in the design of phased array radars which employ a ferrite substrate.

DESCRIPTION: The replacement of mechanically rotating antennas by electronically steered units (phased array radar) is well on its way within the military, and civilian adoption is not far behind. Nevertheless, the orchestration of phases which produces the sweep of the beam is currently both cumbersome and expensive and may remain that way if improvements are not forthcoming. One direction for improvement could come from using ferrite substrate for microstrip patch antennas. By clever control of imposed magnetic fields as well as choices of the gyromagnetic materials, one could achieve rapid and robust control of radiation patterns as well as frequency range and tunability.

PHASE I: The Phase I effort should pursue research regarding the radiation patterns, radiation efficiency, frequency of operation, bandwidth, and input impedance which some idealized choice(s) of substrates, patch geometry and magnetic fields could deliver. A preliminary research code, as proof-of-concept, is expected.

PHASE II: The Phase II effort would consist of a design level code which would, when given tensor permeabilities of the substrate together with imposed magnetic field and realistic geometry of the patches/substrate, predict the operating characteristics listed above.

POTENTIAL COMMERCIAL MARKET: Antennas for airplane/satellite (MILSTAR) communication at 21 and 44 GHz.

AF96-004 TITLE: Forging Process Parameter Optimization

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: The development and implementations of algorithms for the optimization of forging process parameters such as die and preform shapes, temperature control, and ram velocity profiles.

DESCRIPTION: Forging is a primary forming process of great importance in both civilian and military applications. The design of forging process parameters currently relies heavily on trial-and-error. Good commercial non-linear finite element codes have shifted much of the iteration from the shop floor to the computer, but there remains a lack of systematic design procedures. Developing such procedures calls for a multidisciplinary effort, with contributions required in the areas of optimization, materials science, continuum mechanics, and numerical analysis. The research goal is the formulation of optimization schemes that will greatly ease the task of designing a forging. Some issues that should be addressed are the design of multi-step forgings, the trade-off between achieving net shape and achieving a desired material microstructure, design of die and preform shape, reducing tooling stress, and integrating heat treatment with forming. The solutions will be subject to workability constraints, tooling load restrictions, and equipment performance limits. Possible benefits will include reducing process design times, increasing tool life, reducing or eliminating the need for heat treatments after or between forming steps, and producing parts with improved mechanical properties. Implementing the optimization techniques in software, suitable for industrial use, is an important part of this task. The implementation should be "open" to allow the user to formulate customized cost functions.

PHASE I: Develop a flexible optimization scheme that includes several of the capabilities mentioned above. Implement the algorithm in a research-quality software package. Demonstrate the software on sample forging problems.

PHASE II: Implement the Phase I results in a commercial-quality software package. Demonstrate the algorithm on problems of military and industrial interest. Validate some results through test forgings.

POTENTIAL COMMERCIAL MARKET: Forging integrated blade rotors for gas turbine engines; heavy duty crankshafts; connecting rods; gears; hand tools.

AF96-005 TITLE: Human Systems/Subsystems Research

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Human Systems Interface

OBJECTIVE: Develop innovative human-related systems or subsystems for aerospace applications.

DESCRIPTION: Proposers may submit ideas to enhance human performance as an integral part of Air Force systems and operations. Five directorates perform a full spectrum of basic and applied research including exploratory and advanced development: (Specify subtopic by letter).

a. The Human Resources Directorate conducts research in manpower and personnel, force management, training systems (including pilot training) and logistics/information technologies. The objective is to improve operational readiness and control costs by developing technologies for more effective selection, assignment, training and retention of a high quality military force.

b. The Crew Systems Directorate conducts research and development (R&D) to improve human performance, protection, and survivability in operational environments. R&D is conducted to: determine human responses to operational stressors, such as noise, impact, vibration, hostile fire, sustained acceleration, spatial disorientation, altitude, workload, and sustained operations; define human-centered design criteria and concepts for personal protection equipment and workstations; and optimize human-machine integration including visual/auditory displays and crew communication.

c. The Aerospace Medicine Directorate addresses the medical selection, protection and enhancement of humans in Air Force systems and operations. Mission related research and specialized operational support are conducted in aeromedical consultation, epidemiology, drug testing, hyperbaric medicine, and dental devices. Clinical sciences research is conducted to develop standards for aviator selection and retention.

d. The Occupational and Environmental Health Directorate assesses risks to personnel from hazardous materials, toxicology, noise, electromagnetic radiation, (Radio Frequency and Laser) and occupational processes and conducts research to reduce those risks. The goals are to mitigate impacts on health and to enhance the scientific understanding of the underlying biological mechanisms.

e. The Environics Directorate conducts in-house research and manages out-sourced contracted research on innovative technologies to fulfill Air Force requirements for site cleanup and environmental compliance. Site cleanup research emphasizes fuels and solvents. Environmental compliance emphasizes fuels, solvents, and other aerospace materials. Specific areas of research include the behavior, transport, and ultimate fate of chemicals in air, soil, or water; advanced contaminant characterization and pollutant monitoring; contamination cleanup technologies through control, conversion, or destruction using biological, physical, and chemical processes; and hazardous waste minimization. The goal is to find the most efficient, economical, and effective answers to eliminate, substantially reduce, or mitigate environmental consequences of Air Force operations.

REFERENCES:
1. Human Systems Center, "Products and Progress." October 1993. Unclassified. Public Release.
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AF96-006 TITLE: Chemical Reactor Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Quality/Civil Engineering
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop chemical reactor technology for destruction or conversion of hazardous wastes/materials.

DESCRIPTION: Novel and innovative chemical reactor technologies are needed for the destruction or conversion of solid or liquid hazardous wastes or materials. Hazardous wastes and materials of interest include, but are not limited to, energetic chemicals (e.g.; propellants, nitroaromatics) and industrial chemicals (e.g.; halogenated hydrocarbons, complex mixed chemical

wastes, wastes contaminated with metals, contaminated aqueous degreasers, effluents (from paint stripping operations, and emulsions) which are unique to Air Force (DoD) weapons systems and/or industrial support operations. The referenced industrial support operations may be conducted on Air Force (DoD) bases or related installations or contractor-owned sights which directly support Air Force weapons systems. Excluded under this topic are all hazardous wastes and materials that are not unique to Air Force (DoD) weapons systems and operations; materials that are commonly found in use or located at commercial (non-Air Force/DoD) manufacturing and processing facilities; and processes involving biological systems. The reaction chemistry of the proposed reactor system should be limited to temperatures below 125 oC, and pressures below ten (10) atmospheres.

PHASE I: In Phase I, a promising chemical reactor technology will be tested at the bench-scale using representative waste materials, actual or surrogate. Associated unit operations for pre- and post-processing, such as material removal, component separation, and/or effluent treatment required for a complete treatment system must also be identified. The experimental data should be sufficient to determine whether the technology is technically and economically useful for treatment of the target materials and elucidate the key technical issues that must be resolved under Phase II.

PHASE II: In Phase II, the chemical reactor technology will be scaled up to a technically appropriate validation scale and demonstrated as a continuous process. Additional waste materials will be treated to resolve key technical issues, identify all reaction products and effluent characteristics, close all material and energy balances, and provide sufficient data and technical information to allow subsequent design and scale up of the chemical reactor technology to the pilot-scale. A complete process will be proposed, including all ancillary unit operations, preceding and following the chemical reactor, necessary to process the targeted waste materials from their respective sources.

POTENTIAL COMMERCIAL MARKET: While the technology is intended to solve Air Force unique waste treatment requirements, it must also be adaptable for treatment of waste materials generated by commercial industrial operations such as in common chemical processing, industry, plastics/composite material manufacturing, or other such processes which generates complex chemical wastes.

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2. Freeman, H.M., ed., Standard Handbook of Hazardous Waste Treatment and Disposal, McGraw-Hill, New York, NY, 1989.

AF96-007 TITLE: Low-Temperature Treatment Technologies for Dilute Gaseous Effluents

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Quality/Civil Engineering
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop novel low-temperature approaches to treat dilute gaseous effluents.

DESCRIPTION: Explore novel low-temperature (ambient to 125C) approaches for reduction or oxidation of gaseous effluents including Nitrous Oxide (NOx), Carbon Oxide (CO), Particulate Matter Less than 10 Microns (PM10), unburned products of combustion, Volatile Organic Compounds (VOCs) and other hazardous air pollutants (HAPs) that may be effluents from Air Force maintenance or training operations. Concepts considered may include novel low-temperature catalysts, electro-catalysts, radio frequency (RF), plasma, or other hybrid reactor approaches. The characteristics of successful approaches will be their ability to concentrate and/or cause specific targeted molecules in a dilute air stream to react with high conversions at near ambient temperature and pressure. The approach should have the potential for very low operating cost and have minimal energy requirements.

PHASE I: Develop a concept to sufficient level of detail to determine the feasibility of achieving good conversion of gaseous effluents at low-temperature and pressure.

PHASE II: Design and construct a pilot-scale demonstration unit to optimize process parameters and provide performance and economic data.

POTENTIAL COMMERCIAL MARKET: Broad potential application to stationary and mobile combustion sources and corrosion protection operations.

REFERENCES:
1. Nelson, B.W., Van Stone, D. A., and Nelson, S.G., Development and Demonstration of a New Filter System to Control Emissions during Jet Engine Testing, CEL-TR-92-49, Air Force Civil Engineering Support Agency, Tyndall AFB FL, 1992; AD-A-261203.
2. Yang, Y., Togna, A.P., and Blunk, J.R., Oxidative Destruction of Carbon Disulfide Vapors Using Biofiltration, 87th Meeting Air & Waste Management Association, Abstract 94-RA115A.04.1994.

AF96-008 TITLE: Volume Reduction of Aircraft Depainting Wastes

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Quality/Civil Engineering
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop a treatment reducing volume of aircraft depainting wastes prior to disposal as hazardous waste.

DESCRIPTION: For every square foot of aircraft stripped of its paint coatings by plastic media blasting, approximately one pound of dry waste is generated. The waste is composed of approximately 93% spent media and 7% paint residue. The residue is typically composed of polyurethane top coat and a strontium chromate epoxy or polyurethane primer. The metals (particularly the chromate) cause the entire spent media and paint residues to be classified as a hazardous waste. Recent efforts have evaluated media separation and recycling technologies. These technologies have dramatically reduced the volume of waste generated by plastic media depainting. Alternative stripping technologies, such as high-pressure water and medium- pressure bicarbonate blasting, avoid the accumulation of spent blasting media in the waste but still contain paint residues contaminated with metals. A novel method is being sought to treat water blasting paint residue to further reduce the volume or separate the metals (mainly chromate) from the paint residue. This approach can significantly reduce the amount of solid hazardous waste requiring disposal in a landfill and possibly make metals reuse a more economical option. A small stand-alone paint residue reduction system is desired that can be easily integrated with current Air Force depainting operations. Incineration techniques should not be included as they have already been studied.

PHASE I: Conduct bench-scale proof-of-concept studies to demonstrate reduction of paint residues.

PHASE II: Develop a lab-scale reactor to generate process treatment parameters and validate bench-scale results.

POTENTIAL COMMERCIAL MARKET: This technology could be used at all DoD depot operations, commercial airline maintenance facilities, and other industries involved in depainting operations.

REFERENCES:
1. Tapscott, R. E., et al, Plastic Media Blasting Waste Treatments, ESL-TR-88-12, Air Force Engineering and Services Center, Tyndall AFB, Florida. July 1988. AD-A198-059. Unclassified. Distribution Unlimited.
2. Tsang, M.N., et al, Alternative Solvents/Technologies for Paint Stripping: Phase 1, ESL-TR-89-62, Air Force Civil Engineering Support Agency, Tyndall AFB, Florida. March 1994. AD-A279-918. Unclassified. Distribution Unlimited.

AF96-009 TITLE: Remediation Technology for Low Hydraulic Conductivity Soils

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Quality/Civil Engineering
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop an effective method to remediate organic contaminants from low hydraulic conductivity (tight) soil matrices.

DESCRIPTION: Many technologies rely on the movement of groundwater for effective remediation of soils. However, due to restricted groundwater flow or gas transfer, these technologies are ineffective at removing contaminants from low hydraulic conductivity soils (e.g., clay). Clean-up of these soils will depend on the development of innovative biological, physical, and/or chemical remediation technologies which can overcome the limitations imposed by low hydraulic conductivities and limited gas transfer in soils like clay. It should be noted that the Air Force is not interested in pursuing further development of approaches relying on fracturing of the soil matrix.

PHASE I: Phase I would involve laboratory testing of the technology to show the potential it may have for remediating tight soils.

PHASE II: Phase II would involve the development of scale-up parameters and engineering applications information for follow-on testing in the field.

POTENTIAL COMMERCIAL MARKET: Full-scale development of a technology capable of removing/remediating organic contaminants from tight soil interstices could be used at DoD hazardous waste sites as well as similar commercial contaminated sites. In addition, the process may reduce or eliminate groundwater extraction and treatment, further reducing site restoration costs.

REFERENCES:

1. Wittle, J.K. and S. Pamukcu, Electrokinetic treatment of contaminated soils, sludges, and lagoons. Final Report. Department of Energy, Apr 93. AN: DE93040739
2. Anderson D.B., J.N. Hartley, and S.P. Luttrell, Innovative Technology Demonstrations, Department of Energy, Apr 92. AN: DE92015617
3. Reddi, L.N., S. Berliner, and K.Y. Lee, Feasibility of Ultrasonic Enhancement of Flow in Clayey Sands, Journal of Environmental Engineering (ASCE), Vol. 119, No. 4 P 746-752, July/Aug 93.
4. Gibson, T.L., A.S. Abdul, W.A. Glasson, C.C. Ang, and D.W. Gatlin, Vapor Extraction of Volatile Organic Compounds from Clay Soil: A Long-Term Field Pilot Study, Ground Water, Vol 31, No. 4 p616-626, Jul/Aug 93.

AF96-010 TITLE: <u>Horizontal Barrier Technology</u>

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Quality/Civil Engineering
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop a technology to prevent the downward migration of chlorinated solvents into deeper geological strata.

DESCRIPTION: Groundwater contaminated with chlorinated organic compounds represents a threat to public health. This threat is dependent on the contaminants entering ground water in aquifers that are used as sources of drinking water. To prevent the occurrence of contaminants entering these sources, methods are needed to isolate the movements of dense nonaqueous phase liquid (DNAPL) contaminants. One important area of concern involves the development of innovative technologies to prevent the downward migration of DNAPLs. Vertical grout curtains are now placed to limit horizontal movement of contaminated plumes. Newer drilling techniques enable wells to be placed horizontally and may be useful for developing a technique to emplace grout below the contaminated sites to provide the required isolation. If a method can be developed to emplace horizontal curtain "floors," contaminated waste sites can be isolated in all three dimensions.

PHASE I: Phase I would involve laboratory testing of the technology to show the potential it has for forming a contiguous horizontal layer through which DNAPLs would be unable to migrate.

PHASE II: Phase II would involve the development of scale-up parameters and engineering applications information for follow-on testing in the field.

POTENTIAL COMMERCIAL MARKET: Full-scale development of a technology capable of controlling the downward migration of chlorinated solvents or other DNAPLs could be used at DoD hazardous waste sites and similar commercial contaminated sites. In addition, the process may reduce or eliminate groundwater extraction and treatment, further reducing site restoration costs.

REFERENCES:

1. May, J.H., R.J. Larson, P.G. Malone, J.A. Boa, and D.L. Bean, Grouting Techniques in Bottom Sealing of Hazardous Waste Sites. Final report, Jun 82-Sep 85. Environmental Protection Agency, Cincinnati, OH. Hazardous Waste Engineering Research Lab., Jan 86. AN: PB86158664.
2. Ridenour, D.E. and R.K. Saugier, Land Containment System: Horizontal Grout Barrier: A Method for In Situ Waste Management, Annual Meeting of the Air and Waste Management Association, Cincinnati, OH, 19-24 June 1994.
3. Pettit, P.J., D. Ridenour, J. Walker, and K. Saugier, Demonstration of In Situ Constructed Horizontal Soil Containment Barrier at Fernald, Waste Management '94, Tucson, AZ, 27 Feb-3 Mar 1994.
4. Glaeser, E., Horizontal Base Sealing Method Beneath Existing Hazardous Waste Sites-System Zueblin, International

Symposium of the International Association of Engineering Geology on Management of Hazardous Chemical Waste Sites, 9-10 October, 1985, Winston-Salem, NC.

AF96-011 TITLE: Treatment of Trichloroethylene Using Dual Co-Substrates

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Quality/Civil Engineering
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Research the potential of pulsing two different cometabolic substrates to sustain trichloroethylene degradation.

DESCRIPTION: Trichloroethylene (TCE) can be transformed or mineralized by a variety of microbes grown on a wide range of organic compounds including methane, phenol, toluene, propane, methanol, ammonia, and butyrate. However, to date, no cometabolic bioremediation process has been proven to be practical and cost effective for in situ application in the field. One of the unsolved problems involves the inhibition of TCE degradation due to competition by the co-substrate for the active enzyme sites. Researchers have tried pulsing the co-substrate to alternately promote biomass growth/enzyme stimulation with fortuitous TCE degradation. Another potential approach would involve alternately pulsing two different cosubstrates, such as methane and propane. This strategy may alternately stimulate the growth and activity of two distinct microbial populations. Each population, in turn, would degrade TCE when not being fed the primary co-substrate. The potential of this idea has not been tested at the bench- or field-scale level.

PHASE I: Phase I would involve the design and performance of laboratory experiments to determine the potential of sustaining TCE biodegradation by pulsing two different cometabolic substrates. It is critical that the laboratory experiments be designed and conducted so as to achieve a rigorous mass balance of all chemical constituents. Experimental results will yield TCE and co-substrate degradation rates.

PHASE II: Phase II will involve the bench-scale and in situ field testing of the concept proven in Phase I at an Air Force TCE contamination site.

POTENTIAL COMMERCIAL MARKET: TCE is the most frequently encountered groundwater contaminate for both the DoD and private industry. Development of an effective in situ treatment technology would offer savings to the government and private industry in the hundreds of millions of dollars.

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2. Keenen, J.E., S.E. Strand, and H.D. Stensel. 1994. Degradation Kinetics of Chlorinated Solvents By a Propane-Oxidizing Enrichment Culture in: Bioremediation of Chlorinated and Polycyclic Aromatic Hydrocarbon Compounds. Eds. Hinchee et al. Lewis Publishers, Boca Ratan. pp. 1-13.
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4. Semprini, L. and P.L. McCarty. 1991. Comparison Between Model Simulations and Field Results For in-situ Biorestoration of Chlorinated Aliphatics: Part 1, Biostimulation of Methanotropic Bacteria. Ground Water 29:365-374.
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AF96-012 TITLE: Role of Iron in Anaerobic Degradation of Fuel Hydrocarbon

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Quality/Civil Engineering
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Investigate degradation of hydrocarbon fuels in anaerobic soil and groundwater systems under iron-reducing conditions.

DESCRIPTION: Research and development of methods to quantify the role of iron in the anaerobic degradation of hydrocarbon fuels is lacking. Iron is widely found in aquifer sediments but only recently has research into the contribution of iron been discussed as a possible electron acceptor. As a result, the capacity of iron to aid in degradation of hydrocarbon contaminants is not well understood and has not been quantified. Methods are needed to describe the interactions of the hydrocarbon fuel contaminants, anaerobes, and iron present in several mineral forms in the subsurface. In certain situations where the aquifer geologic materials may actually provide a reservoir of natural iron for bacteria to use in the degradation of hydrocarbons, this anaerobic degradation may be very significant. An understanding of the iron interactions may lead to the ability to predict with a degree of certainty the expected contribution of iron at existing waste sites and quantify the expected degradation of the hydrocarbons. Resulting information may be used to enhance existing groundwater contaminant fate and transport models where the oxidizing capacity of iron is not considered but may in fact be a significant source of eventual hydrocarbon degradation and mass loss.

PHASE I: Development and testing of lab methods and procedures for investigating and quantifying which iron minerals are required for hydrocarbon degradation.

PHASE II: Application of methods and procedures to an actual Air Force hydrocarbon contaminated site.

POTENTIAL COMMERCIAL MARKET: Hydrocarbon fuel contaminants are not a DoD unique problem. Developments can be readily applied to the private sector and may improve the scientific foundation of the role of iron in anaerobic degradation of hydrocarbons.

REFERENCES:

1. Baedecker, M.J., I.M. Cozzarelli, D.I. Siegel, P.C. Bennett and R.P. Eganhouse. 1993. Crude oil in shallow sand and gravel aquifer: 3. Biogeochemical reactions and mass balance modeling in anoxic groundwater. Appl. Geochem. 8: 569-586

2. Lovley, D.R., M.J. Baedecker, D.J. Lonergan, I.M. Cozzarelli, E.J. P. Phillips and D.I. Siegel. 1989. Oxidation of aromatic contaminants coupled to microbial iron reduction. Nature. 339: 297-299

AF96-013 TITLE: Development of Automated Radio Frequency Radiation (RFR) Standard Evaluating System

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Modeling and Simulation (M&S)
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop software for use when evaluating whether radio frequency (RF) environments conform to permissible exposure levels.

DESCRIPTION: The interaction of RF and microwave (MW) radiation with biological tissues is of increasing importance from the standpoint of the health and safety of Air Force personnel. Current RF safety standards are becoming more complex. Permissible exposure levels (PEL) are expressed in terms of E-fields, H-fields, power density, induced currents, and contact currents depending on the RF. The averaging time is also frequency dependent. Software is needed to assist personnel in evaluating whether RF environments conform to the PEL. The inputs should be in the form of RF and modulation characteristics. The output should guide the user in determining what parameters to measure in deciding the applicable PEL and in evaluating conformity to current standards.

PHASE I: Phase I will result in the development of a computer program that displays the various PELs for selected RF parameters and investigate the applicability of the phase two modeling effort. Phase I will produce a technical report which fully documents all findings.

PHASE II: Phase II will result in installable software (e.g., Compact Disc (CD) based) for calculating and presenting RF PELS, estimates of field strengths for prescribed RF sources, and other helpful criteria used for evaluating safety standard aspects of selected RF emitters.

POTENTIAL COMMERCIAL MARKET: This research will produce a product that not only can be used to help assure the safety of AF personnel from RF, but can also be used by all people (Government, military, & civilians) concerned with compliance with RFR safety standards, whether the fields emanate from communication systems, radar, Electromagnetic Plus (EMP), or ultrawideband devices. Adaptation of the program to other United States and foreign Radio Frequency Radiation (RFR) standards would make this product have world-wide applicability.

REFERENCES:
IEEE C95.1-1991, IEEE Standard Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 KHz to 300 GHz.

AF96-014 TITLE: Environmental Noise Modeling and Measurement Projects

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Quality/Civil Engineering

OBJECTIVE: Develop improved capabilities for modeling and measuring subsonic and supersonic aircraft noise.

DESCRIPTION: To comply with the requirements of the National Environmental Policy Act, the Air Force must predict the environmental effects of major changes in flight operations, including effects of supersonic and subsonic aircraft noise on humans, animals and structures. Changes for which the noise effects must be assessed include the introduction of new aircraft, moves of squadrons or wings to new locations and development of new training routes, military operations areas, special use airspace and weapons ranges. In order to use scientifically acceptable methodologies for modeling noise exposure and predicting the effects of noise exposure, research and development projects are being sought in the areas of noise measurement and modeling. The Air Force has need for better noise modeling capabilities to assess the impacts of subsonic and supersonic aircraft flight activity. Proposals are invited on all aspects of noise modeling: better propagation algorithms, innovative weather and operations data collection, noise contouring, noise measurement equipment, noise measurement procedures, and interface of models and monitoring data with Geographic Information Systems (GIS).

PHASE I: Phase I will result in feasibility analysis for various noise sources, data collection systems, microphones, methodologies, or improved plotting and GIS application.

PHASE II: Phase II will result in fully developed equipment or computer programs for modeling or measurement of aircraft noise that could be used for civil as well as military noise sources.

POTENTIAL COMMERCIAL MARKET: The research and development efforts needed to predict and assess the effects of aircraft noise will result in technical capabilities that can be used by hundreds of acoustical and contractor firms that support various federal agencies in addressing environmental noise issues. Agencies such as the Army and Navy, the Federal Aviation Administration, the National Aeronautics and Space Administration, the Department of Transportation, and the National Park Service all use commercial acoustics firms to perform acoustic analyses which could potentially use the products of the research and development sought under this solicitation. Zoning boards use it to specify land use.

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5. Sutherland, L., R. Brown, and D. Goerner, Evaluation of Potential Damage to Unconventional Structures by Sonic Booms, HSD-TR-90-021, January 1990, AD (A225 029)

AF96-015 TITLE: Effects of Optical Scattering on Tactical Decision Making

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Modeling and Simulation (M&S)

OBJECTIVE: Develop analysis technique of optical scattering from various media as it relates to visual information processing.

DESCRIPTION: Research is needed to explore the scattering along the complete propagation path of a laser beam as it propagates through the atmosphere, through a windscreen or canopy of an

aircraft, and then through the eye for final image formation. An initial assessment must be made of the relative importance of each of the scattering phenomena and the relevance of each to an overall image. A model would then be developed to determine the visual effect or image produced from a relatively low power laser. This model must include the effects of various atmospheric conditions, different windscreen or canopys, and variations in the human eye. It is known that the general visual effect will be to reduce the contrast between other objects and the background in the rest of the visual field of view. However, a quantitative model has not yet been developed. The reduction in contrast means that it will now be harder to identify or even acquire targets within the visual scene. Targets can be tanks on the ground, other aircraft, a runway, or road signs while driving. The same model for lasers could be used for sun glare, glints, or other headlights. A separate model needs to be developed to predict how the visual effect of scattering will affect tactical decision making. This will include such things as "When will a pilot need to abort a mission?", "When will a mission be unsuccessful?" and "How might tactics be changed so that it will not be necessary to abort a mission?".

PHASE I: Phase I will determine the relative importance of each of the scattering phenomena and the relevance of each to an overall problem. This phase should also detail a modeling plan for the degraded visual effects and the relation to tactical decision making.

PHASE II: Phase II will develop a computer model which would accurately simulate the complete propagation path of a laser beam as it propagates through the atmosphere, through a windscreen or canopy, and then through the eye for final image formation. The model would then use the degraded visual image within a complete tactical decision making environment.

POTENTIAL COMMERCIAL MARKET: The commercialization aspect of the scattering models will help in the development of windscreens (e.g. automobile windshields) that are better able to reduce glare. Glare from the sun or other automobiles is of vital importance to the automobile safety community. These models will not only incorporate windshield shape, but will be able to model residues on the windshield, smog in the cities, and the increased glare experienced by the ageing eye. The model could also be used for canopy acceptance criteria, canopy design, and visor analysis. Other potential uses include commercial aircraft windscreens as well as improved airfield lighting systems. The automotive industry will find models such as this helpful in designing more effective and safer headlights. Different lighting designs could be run through the model in order to determine effects with regard to driving safety.

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3. Searles, Stuart. K., G.A. Hart, and S.T. Hanley, "Laser beam propagation in turbulent conditions," Appl. Opt.,30(4):401-406 (1 February 1991)
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AF96-016 TITLE: Improved Assessment of Vestibular and Oculomotor Function

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Biomedical

OBJECTIVE: Develop innovative concepts, models, and diagnostic tools for evaluation of vestibular and oculomotor system performance.

DESCRIPTION: Properly functioning vestibular and oculomotor systems are critical in dealing with the multisensory environment of flight. Standard clinical tests may not always detect operationally significant levels of vestibular or oculomotor dysfunction. Producing improved vestibular and oculomotor tests may result by upgrading existing tests or by devising new ones. Existing tests could benefit from improved stimulus delivery systems, improved eye-movement recording instrumentation, advanced data collection methodology, innovative data analysis, and improved interpretation.

PHASE I: Phase I will identify, rationalize, and evaluate an approach to the improved assessment of vestibular and/or oculomotor function. This approach may consist of a completely new testing concept, a significant enhancement of a standard testing concept, or a significant component for such a system.

PHASE II: Phase II will develop the concept to the prototype stage, producing a working model of the vestibular

and/or oculomotor testing system and demonstrate the efficacy of the concept. Validation of the prototype by comparing performance to existing commercial systems is highly desirable.

POTENTIAL COMMERCIAL MARKET: An improved system for testing vestibular and oculomotor function will be of interest to Otologists, Otolaryngologists, and Neurologists. The currently available commercial testing devices lack the sensitivity and specificity required for accurate diagnosis of vestibular and oculomotor dysfunction. Once validated, a significantly improved testing system could successfully compete in the commercial marketplace.

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AF96-017 TITLE: <u>Nonisotopic Detection of LSD and/or Methcathinone in Urine</u>

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Biomedical

OBJECTIVE: Develop a stable, sensitive, selective, nonisotopic screening test for LSD and/or methcathinone in urine.

DESCRIPTION: All military urine testing laboratories require a high-throughput qualitative test for LSD, methcathinone, and/or their metabolites in urine. The current method - radioimmunoassay - is being phased out because of problems associated with the storage and disposal of radioactive waste. Thusfar, a nonisotopic method for LSD has not been available. Methcathinone, an easily prepared illegal stimulant with a high abuse potential, has generated a great deal of forensic interest.

PHASE I: Phase I will result in development of test reagents and controls. Reagents should be nonisotopic, stable for at least sixty days, sensitive to LSD concentrations of 100 picograms per milliliter and/or 200 picograms per milliliter of methcathinone, display little cross-reactivity with structurally related compounds (such as tryptophan, other amphetamines, and over-the-counter cold remedies) and no interference from other substances. The cross-reactivity with at least 100 common drugs and structurally related compounds will be quantitatively determined.

PHASE II: Phase II will result in a urine screening kit which is easy to use, capable of rapidly and accurately processing large numbers of samples, and have a usable shelf life of at least 60 days. Kits will be comparably priced with current drug screening tests and will contain a brochure detailing information comparable to that provided by kits currently in use. Each kit will contain accurately quantifiable controls at negative, low (50% of cutoff) cutoff, and high (150% of cutoff) concentrations which will be stable for at least 6 months. The test should easily (at least three standard deviations) differentiate the controls developed.

POTENTIAL COMMERCIAL MARKET: In both military and civilian communities, LSD and methcathinone abuse rates and programmed drug use have increased while dosage levels have decreased. Since both communities have demonstrated an increased interest in testing employees and applicants for drug abuse, there is a general need for developing inexpensive, rapid, sensitive, selective, nonisotopic, high throughput tests. A major advantage is that such tests would avoid the problems and expenses associated with the storage and disposal of radioactive waste.

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AF96-018 TITLE: Development and Evaluation of a Team Performance Assessment Device (TPAD)

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Manpower, Personnel and Training
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Design and develop a computer-administered task suitable for measurement of group performance and interaction.

DESCRIPTION: There is a requirement for a computer-based Team Performance Assessment Device that allows for the measurement of group interactions and outcomes. Performance must be sensitive to the effect of team composition and individual differences variables, such as mental aptitude, personality characteristics, gender and ethnicity. The task should be designed to simulate the requirements for team members' cooperation of real-world tasks such as a crew flying an aircraft. The software that generates the task should also collect real-time performance measures from each team member that can be used to evaluate individual and team contributions to performance at specific points in time. Another requirement of the task software is that it allows the task to be configured for different research applications and various degrees of task specificity, from a generic version that requires minimal task knowledge, to versions suitable for use with aircrews, tank teams, etc.

PHASE I: Phase I will result in development of a prototype version of the generic Team Performance Assessment Device configuration and fully documented specifications, including software, hardware, and maintenance requirements for the operational Team Performance Assessment Device configuration.

PHASE II: Phase II will result in a fully documented development of the Team Performance Assessment Device, including all hardware and software required for the non-generic Team Performance Assessment Device configurations, and an evaluation of the task performance system for its validity as a measure of group interaction and performance, both in an experimental laboratory setting using a generic configuration and in an example application using a task-specific configuration.

POTENTIAL COMMERCIAL MARKET: The Team Performance Assessment Device will have applications to any organization that selects and trains individuals to function as a team in a human-computer systems interface. Military applications include teams operating aircraft, tanks, and landing craft air cushion vehicles. Civilian applications include aircrews, nuclear power plant operators, and medical operating room personnel. The Team Performance Assessment Device will be particularly attractive to smaller organizations such as regional airlines that operate with limited resources available for skills training and performance assessment.

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AF96-019 TITLE: Environmentally Compliant Power Sources for Aerospace Ground Equipment

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Quality/Civil Engineering

OBJECTIVE: Develop a zero-emissions prototype power source sufficient for anticipated flightline support equipment needs.

DESCRIPTION: There is a requirement to produce power sources that reduce the amount of emissions of Clean Air Act criteria pollutants from the operation of internal combustion engines in flightline support equipment. The equipment currently includes diesel, gasoline, and jet fuel operated reciprocating engines in the 50-200 hp range, and turbine engines ranging from 6-7.2 mBTUs. At the present time, NOx emissions have to be reduced at a minimum to 4g/brake-hp-hour; however, zero emissions

of criteria pollutants and reduction of hazardous air pollutants (HAPs) is the desired environmental goal. Demonstration of technology resulting in the replacement of existing equipment/fuels with alternative methods of power generation meeting these emissions requirements is the desired outcome of this research.

PHASE I: Phase I will result in a feasibility analysis for a proposed power source. This assessment will provide a complete description of the proposed solution, including justification for its selection. Also included will be a complete detailed description of the selected technology, rationale that adequately establishes the success of proposed emissions reductions methodology, and results of any previous related research. Cost information will be presented, including those associated with the engineering development, operations, maintenance, and repair costs of the proposed power source. A plan describing the ability to implement the proposed power source will be included. These products will be presented in the form of a briefing and a technical report.

PHASE II: Phase II will result in the development of prototype technology that demonstrates the concepts detailed in Phase I. This prototype will be capable of adequately meeting the power requirements described above, while meeting zero or near-zero (less than 4g/brake-hp-hour) emissions levels. The emissions levels must be demonstrated and proven (by an independent testing source) to be within these standards. Accompanying this prototype will be a technical report that provides a complete engineering description of the technology, a description of risks and costs associated with the large scale development of the prototype, and a full-scale implementation plan.

POTENTIAL COMMERCIAL MARKET: Because the mandates established in the Clean Air Act are applicable to any emission source, this technology could be utilized by the commercial airline industry as well. Along those same lines, the stringent requirements found in this law make the development of low or zero emissions power source an attractive option for many other industrial applications.

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AF96-020 TITLE: Develop Market-Ready Authoring Tools for Intelligent Tutoring Systems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Manpower, Personnel and Training

OBJECTIVE: Develop proof-of-principle authoring tools that support easy development/maintenance of Intelligent Tutoring Systems.

DESCRIPTION: There is a requirement for authoring tools which support easy development and maintenance of intelligent tutors and interactive courseware. This topic is related to the DoD thrust on Technology for Training and Readiness. Successful programs of basic research in the area of intelligent automated instruction (Intelligent Tutoring Systems - ITS) are described across a diverse array of professional, technical, and scientific publications. There is an opportunity for focused transition of this emerging technology out of research laboratories and into more applied settings in part, because current-generation microprocessors offer powerful delivery platforms at reasonable expense. The challenge that remains, however, is to scale up from isolated and simplistic laboratory instructional domains to fully developed real-world instructional domains. Three related issues stand in the way of scaling up. First, instructional techniques used by any particular researcher in the ITS field tend to be applied to one instructional domain or a small number of closely related instructional domains. Thus, the generality of the instructional technique is in question. Second, student modeling frameworks used by any particular researcher in the ITS field tend to be applied to one instructional domain or a small number of closely related instructional domains. Thus, the generality of the student modeling framework technique is in question. Third, the tutoring systems developed by researchers in the ITS field tend to be monumental individually-tailored programs sometimes written in exotic languages. The potential for cost-effective implementation and maintenance of such tutoring systems is in question. Innovative respondents to this topic will address one or more of these issues by developing authoring tools which support easy development and maintenance of intelligent tutors that apply proven instructional strategies using general-purpose student modeling frameworks in individual or collaborative settings.

PHASE I: Phase I will result in proof-of-principle development tools and a technical report which demonstrates that it is possible to provide instructional authors with the capability to easily implement instruction that is pedagogically sound, in

that it is based on instructional strategies validated through pedagogical, preferably empirical, research.

PHASE II: Phase II will result in an expanded full-scale, tested authoring system prototype and a technical report supporting a broad range of instructional domains requiring different pedagogical strategies.

POTENTIAL COMMERCIAL MARKET: Significant dual-use potential exists for commercially viable authoring tools which can be marketed as ITS authoring tools or used to produce ITS in a broad range of domains. Examples might include advanced mathematics (calculus, trigonometry, etc.), physics or other scientific disciplines, flight dynamics, orbital mechanics, or computer programming.

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AF96-021 TITLE: Personal Computer (PC)-Based Image Generator for Simulating Flight

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Modeling and Simulation (M&S)
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop a high-fidelity daytime and night-vision device image generator based on PC-compatible hardware.

DESCRIPTION: There is a requirement for a low-cost high-fidelity image generator for out-the-window imagery in flight simulation. Low cost will be assured by basing the system on an IBM-compatible personal computer. High fidelity will be achieved through the use of state-of-the-art graphics accelerators using computationally efficient techniques for generating terrain textures which are mapped onto the terrain height map.

PHASE I: Phase I will result in PC-based hardware and software for generating and displaying a 1024 x 1024 x 8-bit per color image with a noninterlaced update rate of 60 frames per second and a technical report. The hardware must be designed around a high-performance graphics accelerator that will be available commercially within two-to-three months of Phase I funding, and is likely to be developed further by the manufacturer. The graphics accelerator must be readily scaleable into a multiprocessor system, and a detailed estimate must be provided as to the number of graphics accelerators that will ultimately be required to generate the full-resolution real-time system as described above. An image display bus must also be identified, and it must be demonstrated that the chosen graphics accelerator will be compatible with it. The software must include computationally efficient techniques for generating and rendering all required imagery. Novel terrain-texture mapping techniques and techniques for implementing coordinate transformations (in six degrees of freedom) are also required in order to assure that high fidelity will be achieved with minimal hardware in all future implementations of the system. In order to assure that it will be feasible to implement any required novel techniques on a PC-based system, functioning software that displays a simple height map surface and allows user selectable movement about the generated (untextured) scene in six degrees of freedom will be delivered under Phase I, along with a technical report.

PHASE II: Phase II will result in a prototype image generator system based on the hardware and software design completed in Phase I and a final technical report. A preliminary database system will be developed that includes methods for converting existing commercial databases into a form compatible with the software described above and transferring those databases to the proposed image generator. Finally, all hardware and software should be sufficiently documented such that a preliminary evaluation of the prototypes can be carried out at selected operational sites to be identified during Phase I.

POTENTIAL COMMERCIAL MARKET: Dual-use potential exists for commercial flight simulation, video games and scientific visualization of multidimensional data. Applications of the PC-based image generator for flight training in both the commercial

and private sectors could be extensive. Currently, the high cost of aircrew training is driven by the requirements for main-frame (or equivalent) computer support.

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AF96-022 TITLE: Advanced Audio and Virtual Human Sensory Interfaces

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Human Systems Interface

OBJECTIVE: Enhance operational Air Force audio systems and integrate human sensory feedback with virtual reality.

DESCRIPTION: A requirement exists for effective voice communications, crew safety, human performance and telerobotic system controls that are based on natural intuitive interfaces using innovative abilities and not requiring learning or training for efficient operation. The intuitive interfaces facilitate operator task performance, reduce workload and fatigue, and improve personal safety. These intuitive interface technologies include, but are not limited to: 1) auditory system modeling and neural networks for robust signal processing of speech, 2) digital audio technology to allow integration into aircraft systems, 3) voice communications countermeasures/counter- countermeasures, 4) noise-induced hearing loss protection, 5) active noise reduction, 6) three-dimensional auditory display for spatial awareness and communications, 7) natural stimulation for perception of remotely-sensed tactile information, 8) high-fidelity force-reflecting haptic interface devices, 9) perceptually-driven control methods for telerobotic systems, 10) integrated hardware/software to superimpose position-calibrated virtual reality models with real time video imagery, and 11) efficient computational algorithms for synthesizing interaction forces between virtual objects in a virtual environment. A single interface issue or any combination of interface issues may be addressed in the offerer's proposal.

PHASE I: Phase I efforts would provide an assessment of the state of the art and an approach to develop an appropriate intuitive interface technology.

PHASE II: Phase II efforts would provide a demonstration and validation of the intuitive interface technology.

POTENTIAL COMMERCIAL MARKET: Commercial applications of these technologies are possible in the commercial aviation, entertainment, industrial safety, and health care fields, as well as in telemedicine, environmental cleanup, and nuclear facility operation.

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AF96-023 TITLE: Production of Custom Fit Oxygen Masks Using Rapid Prototyping Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Human Systems Interface

OBJECTIVE: Develop an efficient method for rapid, inexpensive production of individual custom-fitting oxygen masks.

DESCRIPTION: Proper aircrew oxygen mask fit is often difficult because each individual's facial shape is unique, but only a few standard mask sizes exist. Additionally, the high acceleration of today's fighter aircraft and the resulting requirement for positive pressure breathing have increased the fit problem, leading to compromises in both performance and comfort. The current sizes of oxygen masks used in high performance aircraft were developed to fit male anthropometry and probably do not adequately fit a large portion of the female population. In addition, current mask designs are uncomfortable for many individuals. If aircrew are unable to acquire a proper fit with the current masks, their safety could be compromised. The current method for producing custom oxygen masks for individuals is a very time-consuming and labor-intensive process. Consequently, there is a need to develop a new method to custom fit individuals with oxygen masks which seal under positive pressures as high as 60 mm Hg. Currently, custom masks are made by forming a plaster cast of the individual's face. This is an uncomfortable process for the subject and is tedious for the technician doing the work. A new custom mask-making process should involve a more automated approach to acquiring the anthropometric data on each individual. If data could be obtained to create a computer file for a custom mask, current rapid prototyping technologies may permit production of an individual custom-fit mask. It is desirable to automate custom mask production to decrease the time and labor necessary for production. Ideally, this should allow life support technicians to easily produce custom masks within two days following the initial contact with the subject. These custom masks should be a customization of the MBU-20/P oxygen mask currently used by the Air Force.

PHASE I: Develop a method for automating anthropometric data collection on an individual's face for which a custom mask is to be made. This process should be non-invasive, with a minimum of contact with the subject (1 hour maximum). Data should include not only surface topography, but subsurface skeletal characteristics which are of concern in providing a mask seal under pressure.

PHASE II: Produce a hardware prototype custom oxygen mask using rapid prototyping technologies and data collected from an individual by a process developed in Phase I. The mask must be capable of sealing on the subject's face at breathing pressures of up to 60 mm Hg. This system must be capable of producing a custom mask for an individual within two days.

POTENTIAL COMMERCIAL MARKET: Anticipated civilian applications include commercial airline oxygen equipment, firefighter protective masks, respiratory systems for hazardous waste clean-up, and medical oxygen masks.

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AF96-024 TITLE: Embedded Cockpit Information Controls and Display Concepts

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Human Systems Interface

OBJECTIVE: Develop innovative control and display interface concepts for embedded cockpits in "no external visual" environments.

DESCRIPTION: Limited external visuals due to weather, night operations and smoke/smog have always been a problem for aircraft operation. The future air-combat environment is threatened by lasers, used as weapons of war or terrorism, which may directly attack the human visual system. One solution supporting continued operations in this future air-combat environment is the use of closed crew stations. The closed crew station was originally described in the Air Force's Project Forecast II. In addition to supporting operations in hostile environments, situation awareness may be enhanced within a closed crew station even when used in a less hostile environment. The closed crew station not only requires real-time synthetic vision, audition, and haptic displays, but also the ability for the human to comprehend and interact with the information. Closed crew station display and control concepts can be driven from two perspectives: either from a human-centered perspective or from a hardware perspective. Within the human-centered perspective, the pilot's perceptual, cognitive, and performance characteristics drive the

creation of the interface concept. Within the hardware perspective, the characteristics of militarized versions of advanced displays and controls, such as wide-area vehicle-mounted displays drive the creation of interface concepts. The Air Force is seeking new interface concepts which enable human interaction with, and control over, the flight environment while enhancing the performance of all flight and offensive/defensive weapon delivery activities. The concept of a closed crew station using vehicle-mounted displays requires innovative pilot-vehicle interface (PVI) and information management technologies, coupled with the current advances in high definition, large surface and projection display technologies.

PHASE I: Create innovative interface concepts, determine the technical merit and feasibility of new concepts, and provide a demonstration of each concept.

PHASE II: Optimize the designs of the interface concepts and provide a prototype demonstration of the new interface concepts embedded within a crew station environment.

POTENTIAL COMMERCIAL MARKET: These concepts can be useful for civil and general aviation use under severe instrument flight rule conditions, making flight conditions safer, more affordable, and more available. In addition, the home entertainment market is moving toward full-immersion virtual reality displays for personal computer games as well as dedicated game platforms. Flight simulation has always been a large portion of the home game market, and these concepts may transfer into new full-immersion flight simulation game concepts.

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AF96-025 TITLE: <u>Advanced Escape Technologies and Ejection Data Recording for Aircrew Members</u>

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Human Systems Interface

OBJECTIVE: Improve aircrew escape systems through the use of ejection data recording and enhanced restraint systems

DESCRIPTION: DoD has incorporated women into the cockpits of combat aircraft. Presently, all flyers must meet long standing entrance requirements for body size. New training aircraft will accommodate a much broader range of occupant sizes. This expanded flying population will eventually fly ejection seat-equipped aircraft. This has generated a requirement for novel methods of providing restraint and harnesses, improved effectiveness in seat adjustability, control of aerodynamic loads to optimize these forces for the wide range of occupant weights, and recording of the seat response during an ejection. Contractors' proposals may address one or more of these issues related to advanced escape technologies. An integral part of these new requirements for the expanded aircrew population is the need to identify, develop, and test restraint and parachute harness systems which are compatible with an adjustable seat to better fit the expanded population range in escape systems. This research should examine the design of the restraint and harness system and the attachment points to the seat as well as innovative techniques for adjusting the ejection seat within the cockpit. The technique should allow the expanded range of occupants to be located within the cockpit for proper vision while maintaining acceptable arm and leg reach envelopes. Contour and adjustability of the seat bucket and cushions shall also be examined to determine the adjustments required to provide support and comfort for the expanded population. Closely associated with these new restraint and seat adjustment designs is the need to measure the actual ejection events by some type of "in seat" instrumentation package. The package needs to be a small battery-operated data recorder/analyzer that uses internal sensors and attaches to the ejection seat. The collected data will be used to validate and improve the design of the ejection seat and restraint mechanisms in an attempt to reduce future injuries and deaths during ejections from aircraft. Current data have been obtained primarily from rocket sled ejection using manikins. No human data is being gathered on actual in-flight emergency ejection, since no ejection seats are fitted with data recorders.

PHASE I: Phase I will result in the identification and preliminary evaluation of advanced restraint and harness systems, advanced ejection seat adjustment concepts, and/or the design and construction of a prototype data recorder.

PHASE II: Phase II will yield fully tested promising technologies including the integration of the recorder into R&D ejection seats for live-fire tests.

POTENTIAL COMMERCIAL MARKET: Anticipated civilian applications include improved restraint technologies for the

automobile and airline industries and innovative instrumentation measurement packages for the automobile testing industry.

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AF96-026 TITLE: Chemical/Biological Warfare Defense Detection and Decontamination Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Chemical and Biological Defense
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop novel technology and methodology that will detect, identify, quantify and decontaminate biological/chemical agents.

DESCRIPTION: This requirement is for novel methods and technologies for the detection (ability to detect, identify, and quantify) and the decontamination of highly toxic chemicals and pathogens (bacteria, viruses, spores, toxins, and other materials of biological origin). These methods and technologies will be used to address needs on airbases, aircraft, and for personnel.
Special interest exists in technologies that can continuously monitor and rapidly provide detection and warning for the presence of hazardous materials existing in liquid phase, vapor phase, aqueous solution, or as aerosols. The sensitivity required is: 1) in the vapor or aerosol state - parts per billion or less than 100 spores, bacteria, and viruses; 2) in liquid state - 100 micrograms; and 3) in aqueous solutions - parts per million or less than 100 spores, bacteria, and viruses per liter. The realm of technologies of interest includes (but is not limited to): antigen/antibody interactions for biologicals, PCR/DNA probe technologies for biologicals, ion mobility spectroscopy technology for chemicals, chemiluminescent techniques, surface acoustic wave devices for chemicals, light scattering techniques for differentiating biological/non-biological particles, multifrequency laser excited fluorescence spectroscopy of biologicals, and near infrared Raman spectroscopy. In addition, novel but simple and facile methods for the removal, detoxification, or destruction of toxic materials (both chemical and biological) are desired. The method must be environmentally friendly, safe to use on aircraft materials, and non-hazardous to personnel. The optimal method will involve inexpensive materials and/or devices, be highly mobile, and rapid. The contractor's proposal may address this requirement in part (specific proposals for chemical detection, biological detection or decontamination are acceptable).

PHASE I: Phase I will result in the design and fabrication of a laboratory breadboard system which shall demonstrate the proof-of-concept with the use of chemical and/or biological agent simulants.

PHASE II: Phase II will design, optimize, and fabricate a brassboard system that will be laboratory and field tested against a range of chemical/biological simulants. The brassboard system will be delivered to the Air Force for an in-depth evaluation of the system's potential.

POTENTIAL COMMERCIAL MARKET: The problem that is being addressed by this topic is a subset of a much larger issue in the area of environmental health and safety. The technologies that can be applied to this topic can be easily adapted to handle problems that are of interest outside of the military. For example, biological detection systems that are designed to detect and identify biological warfare agents can be readily modified to detect and identify harmful bacteria in food or medical diagnostic for bacterial or viral infections. The chemical detection systems can be used by industry to monitor hazardous conditions in the work place (paint solvents, cleaning solvents, pesticides, laboratory safety, warehouse fires, etc.). The decontamination technologies can be used to clean-up hazardous waste spills from accidents, clean-up superfund sites, etc.

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AF96-027 TITLE: Development of Easy Application Skin Biopotential Electrode

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Human Systems Interface

OBJECTIVE: Develop a high quality biopotential skin electrode that does not require skin preparation.

DESCRIPTION: Physiological data are being used to monitor pilot and other operator states using brain wave, heart rate, eye blink and respiration data. One problem that is impeding the more wide-spread use of these methods is the lack of easily applied electrodes. Electrode applications that require skin preparation in order to achieve acceptable impedances take too long in operational settings. In operational settings, electrodes must be quickly applied, have low impedance and not add noise to the biological signals. Rapidly applied electrodes that require no skin preparation, yet are capable of providing high quality signals are needed for these applications. Electrodes are required that do not cause skin irritation with repeated use from day-to-day and can be used without problems during continuous operations over long periods of time. They should produce data of excellent quality that is immune to artifacts caused by movements, sweating, or drying out over extended use and are immune to environmental electrical noise. Active electrodes that are small and inexpensive could be developed. They must be capable of being worn under helmets, caps and other clothing and must be acceptable to the wearer. The electrodes must be compatible with commonly used amplifiers and pose no hazard to the wearer. These electrodes could also be used by medical personnel in battlefield situations where quick evaluation of casualties is required.

PHASE I: Phase I will result in the identification and preliminary testing of candidate technologies.

PHASE II: Phase II will result in fully tested electrodes.

POTENTIAL COMMERCIAL MARKET: These electrodes could be used in medical environments where rapid evaluation of patients is required, such as in trauma and emergency centers and by emergency squads. They could save valuable time when assessing trauma patients. They would also be used in electroencephalography and cardiology laboratories in hospitals and clinics, since they are quickly applied and do not produce skin irritation. There is a very large market for electrodes in these fields and the ease of application would make these electrodes popular. Research laboratories would also make use of these electrodes for the same reasons.

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AF96-028 TITLE: Head-Mounted Thermal Imager

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop the technology for mounting thermal imagers onto a helmet-based system.

DESCRIPTION: Currently, there are two types of helmet-mounted night vision technology being used. One involves visible and near-infrared light detectors and amplification packaged into a small binocular-like configuration (i.e., night vision goggles (NVG). A deficiency of NVGs, however, is their limited resolution in extremely low light illumination levels. The other

technology being used employs coupling a pod-mounted thermal imager with a helmet-mounted display. This configuration is excellent for low light illumination conditions. A problem exists with this approach, however, in that pod-mounted sensors need cooling, are heavy, cause wind drag, and are costly. With the advent of thermal imagers capable of room temperature operation, it is desirable now to identify, develop, and test an helmet-mounted thermal imager, sensitive to radiation wavelengths in the 3-5 and 8-12 micron windows, thus eliminating the need for external pod-mounting modifications.

PHASE I: Phase I will result in the examination of the concept and a breadboard design of candidate human/sensor interfaces.

PHASE II: Phase II will result in prototyping and field testing of the most promising approach.

POTENTIAL COMMERCIAL MARKET: This technology has wide commercial appeal. This includes surveillance for law enforcement, night search and rescue for the Coast Guard, and visually assessing home heat loss caused by inadequate insulation for the heating and air-conditioning industry.

REFERENCES:
1. Task, H. L. and D. F. Kocian, (1992). Design and integration issues of visually coupled systems (SPIE SC54). Short course presented at SPIE's OE/Aerospace Sensing 1992 International Symposium, Orlando, FL (DTIC AD: A). Unclassified. Distribution Unlimited.
2. SPIE Vol. 2020 Infrared Technology XIX (1993), Session 5: Room-Temperature Infrared Solid State Imagers, San Diego, CA (Open Literature).

AF96-029 TITLE: C4I Systems/Subsystems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Command, Control and Communications (C3)

OBJECTIVE: Develop innovative concepts for improving or increasing the capability of Air Force command, control, communication, computer and information systems or subsystems.

DESCRIPTION: Proposals may address any aspect of C4I systems not specifically covered by other SBIR topics. Areas of interest include, but are not limited to, innovative approaches to accomplishing the following: Planning tools, possibly employing satellite data, which provide multidimensional map displays interactive with city building and street plans and utility systems; employing commercial off-the-shelf communications technology; definition and development of qualitative and quantitative metrics and exit criteria associated with developing and producing C4I-related products and technologies; radio frequency technology and wireless communications for use in warehouse, fuels, and other hazardous operations; data compression/handling algorithms for satellite data links; tools for modernization of base-level business processes; more efficient modulation techniques and protocols that lead to low-cost small-size higher-throughput airborne SATCOM terminals; improved human interfaces for airborne radar. Proposal titles must reflect the specific C4I problem being addressed.

PHASE I: Provide a report which describes the proposed concept in detail and shows its viability and feasibility.

PHASE II: Fabricate and demonstrate a prototype device or subsystem or software program.

POTENTIAL COMMERCIAL MARKET: All solutions proposed must have potential for use/application in the commercial as well as military sector, and potential commercial applications must be discussed in the proposal.

AF96-030 TITLE: Automatic Agent/Expert Technology Algorithms

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop automatic agent/expert technology algorithms to assess various situations and make recommendations to commanders or operators.

DESCRIPTION: Automatic agent/expert technology algorithms are sought which would assess a situation and make recommendations to a commander or operator. Applications could include battle management, where the expert algorithm would assess the battle situation and make recommendations based on current US policy and theater rules of engagement; surveillance

and/or weapons management, which would require assessment of the situation and recommendations to an operator concerning sensor modes, potentially dangerous situations needing attention, basic display setups, rules of the road based on experienced operator opinions, etc. The proposal should identify the Air Force system on which the proposed algorithms would be used.

PHASE I: Provide a report describing the methodology to be used in the algorithm and its specific application and functions, and showing its viability and feasibility. If the algorithm to be developed is based on an existing product, provide a demonstration of this existing product.

PHASE II: Develop and demonstrate a prototype algorithm.

POTENTIAL COMMERCIAL MARKET: The basic framework of successful expert algorithms could be used by public safety agencies in emergency situations, in the operation of nuclear and non-nuclear power plants, in emergency situations in the operation of aircraft and ships, or in any area where a human operator required assistance in a complex situation.

AF96-031 TITLE: Passive Tracking of Airborne Targets

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop passive means of establishing state vector estimates on dynamic, time-critical, airborne vehicles.

DESCRIPTION: Passive sensors offer significant military advantages. However, in general, these sensors offer only measurement data. It became apparent during Desert Storm in efforts to counter the theater ballistic missile threat that a capability was needed to process optical or IR information and establish improved state vector estimates on these dynamic, time-critical targets. Innovative methods are sought which would employ passive observations to provide three-dimensional location and velocity of rapidly-maneuvering airborne vehicles. Systems to be considered may be based on single or multiple measurement devices on airborne and/or ground-based platforms; airborne observation platforms themselves must be considered as maneuvering; weather must not be a limiting factor. Only minimal a priori knowledge of the particular target type should be required, and no cooperative identification responses should be assumed. The target set to be considered includes boosting theater ballistic missiles as well as air-breathing threats such as aircraft and cruise missiles. Tracking solutions to these threats must be computationally realized within the operational timelines of the threat. Potential corollary investigations may include rapid typing of boosting ballistic missiles, estimates of booster engine cut-off time, discrimination of surface-to-air, short range and cruise missiles.

PHASE I: Provide a report describing the methodology to be used with suitable analysis to indicate its feasibility. The report should outline the approach which would be employed in demonstrating the feasibility in Phase II and the resources which would be required.

PHASE II: Develop and demonstrate a prototype.

POTENTIAL COMMERCIAL MARKET: A successful passive tracking scheme would be applicable to all military reconnaissance and surveillance missions. It could be of significant value in civil air traffic control, particularly in tracking private aircraft at low altitude in the vicinity of airports. If the methodology results in a way to mitigate the effects of weather and ground clutter which currently limits the effectiveness of radar, it could be extrapolated to use in many additional tracking applications, such as airport ground movements, seagoing vessels in waterways and ports, public safety, etc.

AF96-032 TITLE: Broadcast and Internet Link Security Measures

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Command, Control and Communications (C3)

OBJECTIVE: Develop innovative concepts for denying unauthorized access to broadcast and interactive networks.

DESCRIPTION: Future Air Force communication architectures will employ broadcast Satellite Communication (SATCOM) networks such that various channels will contain different categories of information such as weather, air situation, tasking, etc. Retrieval and interaction by users on the network must be flexible and dynamically executed. All of these characteristics potentially facilitate access to the network and information contained on it by unauthorized users. Measures, including both active and passive techniques, are needed to identify and deny access to unauthorized users.

PHASE I: Provide a report which describes the proposed concept in detail and shows its viability and feasibility.
PHASE II: Fabricate and demonstrate a prototype.

POTENTIAL COMMERCIAL MARKET: Techniques developed under this topic would have immediate and widespread applicability to commercial, private user and public safety broadcast information transfer.

AF96-033 TITLE: Innovative C3I Technologies

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Command, Control and Communications (C3)

OBJECTIVE: Develop innovative technologies for enhancing the performance, availability and affordability of C3I systems and subsystems.

DESCRIPTION: Proposals may address any aspect of C3I pervasive technologies not specifically covered by other SBIR topics. Areas of interest include, but are not limited to, innovative concepts and technologies in: communications, including networks and network management, radio and wireless communications; radar signal, image and speech processing; computer science, including software engineering, computer systems technology and artificial intelligence; electromagnetic (EM) technology, including phased array antennas, null steering and scattering, EM materials and components, EM modeling of ultra low sidelobe antennas mounted on aircraft and EM effects modeling of advanced circuits and packaged modules; reliability and diagnostic technology; virtual reality and other information presentation technologies; and information warfare technologies emphasizing information protection. This topic offers great flexibility for proposers to offer innovative technologies with revolutionary impact on C3I systems and subsystems. Proposal titles must reflect the specific technology problem being addressed.
PHASE I: Provide a report describing the proposed concept in detail and show its viability and feasibility.
PHASE II: Fabricate and demonstrate a prototype device, subsystem or software program.

POTENTIAL COMMERCIAL MARKET: Many C3I technologies have substantial dual-use potential and will impact competitiveness and performance of the commercial sector as well as the military sector. All solutions proposed must have potential for use/application in the commercial as well as military sector, and potential commercial applications must be discussed in the proposal.

AF96-034 TITLE: Intelligent Software for Information Architectures

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Investigate and develop intelligent software mechanisms to enhance information discovery within high-capacity, scalable electronic and/or optical information architectures.

DESCRIPTION: As the 21st century approaches, data/knowledge base size, type, and the ability to share large amounts of information within complex information architectures will become a growing problem. Use of real-time, intelligent software to manipulate large amounts of information will become a necessity. Ways to integrate intelligent software mechanisms are needed in areas which ARPA and Rome Lab are exploring for scalable, electronic, optical, high-powered work environments, networks of workstations, and high performance computing platforms. Area of investigation should include: (1) Innovative software mechanisms which can generate, communicate, and infuse raw computational power for data/knowledge base processing paradigms such as portable personal automated agents. (2) Intelligent ways to integrate (glue) various forms of raw data, with innovative data structures spanning multilevel, robust, information architectures. (3) Innovative ways to use intelligent software objects for information discovery using: (a) seamless knowledge based agents scanning advanced information repositories, (b) cooperative rethinking algorithms for rapid feedback and reconfigurability, and (c) intelligent software infrastructures for personal smart equipment.

PHASE I: Investigate the development of techniques to use intelligent software infrastructures for real-time information discovery using massive multisource data rich repositories.

PHASE II: Demonstrate integrated software objects for personal information discovery in appropriate, scalable, information-processing domains/platforms.

POTENTIAL COMMERCIAL MARKET: Rapid accessibility to integrated systems and information increases choices for consumers in both civilian and defense applications. This technology could have a major impact on applications that require integrated decision making and timely and accurate information such as planning/scheduling systems, autonomous vehicles, aircraft operation, hospital life-support systems, decision support systems and personal military command and control.

AF96-035 TITLE: Intelligent Systems Technology Development

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Command, Control and Communications (C3)

OBJECTIVE: Investigate a common core of capabilities for designing, engineering and integrating intelligent systems which provide timely and accurate information and services.

DESCRIPTION: Integrated access and cooperation among functionally independent intelligent systems and information bases is becoming increasingly critical to support planning and optimization efforts for a number of applications. Quite often, complexity is overwhelming due to several interrelated factors - vast amounts of data, difficulty in defining the goals and constraints of the problem, a dynamic and stochastic environment, computational complexity of the problem, and independently developed and geographically-distributed subsystems. Research areas of interest include: collaborative computing, representation languages and standards, negotiation and reasoning protocols, planning, resource allocation, active data/knowledge bases, machine learning and human-computer interaction. A user-driven engineering approach is encouraged with emphasis on artificial intelligence and operations research basic strategies and techniques.

PHASE I: Identify, investigate and prototype advanced capabilities and identify potential users of these products.

PHASE II: Fully develop and demonstrate unique capabilities from Phase I in both military and commercial domains.

AF96-036 TITLE: C3I Parallel Software Template System

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop and demonstrate a system to produce parallel software for C3I systems that is user-friendly and template driven.

DESCRIPTION: As Massively Parallel Processing (MPP) and Symmetric Multi- Processing (SMP) systems find their way into fielded Command, Control, Communications, & Intelligence (C3I) systems, the continuing challenge is the development of the software for these computing systems. One of the techniques for reducing the costs, and maintaining the quality of this software is through the use of software templates. The C3I Parallel Benchmark Suite (C3IPBS), currently under development at Rome Laboratory, will create a suite of C3I function specifications that can be used to benchmark the parallel computer hardware performance, and the software productivity on these systems. It is envisioned that these specifications can also be used as code templates to create the functions to execute on different parallel processing platforms. The goal of this SBIR is to create and demonstrate a system for developing parallel software for C3I functions using templates derived from the C3IPBS. This system should be user-friendly in its approach, presenting to the user the template for the given function obtained from a library of templates contained within the system.

PHASE I: Perform a functional analysis and clearly describe the design of the desired system.

PHASE II: Develop a prototype system and demonstrate the level of functionality incorporated in the design in Phase I using a real-world system.

POTENTIAL COMMERCIAL MARKET: As C3I systems continue to grow in importance for both the military and commercial sectors, the need for advanced tools to assist in the development of these systems will also continue to grow. The integration of MPP and SMP systems will drive software development and maintenance costs upward. If the proposed topic is determined to be feasible it could be widely used throughout the commercial sector to lower software development costs and time.

AF96-037 TITLE: Integrated Performance Support for Task Automation (IPSTA)

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Command, Control and Communications (C3)

OBJECTIVE: Demonstrate and implement capabilities for dynamically generated, task and context sensitive, process-oriented performance support.

DESCRIPTION: DOD faces the challenge of providing a highly adaptable defense capability with diminishing resources. This will only be accomplished using sophisticated and adaptable computer systems. Resource constraints will at the same time reduce the ability to provide adequate training. IPSTA will greatly reduce the need for training by blending together learning and doing. It will support flexible C3 solutions, enabling the system and user to rapidly evolve to address new situations. IPSTA depends on emerging technology in which enactments of process models form the basis for software systems. It will extend artificial technology in explanation generation to apply to application software processes. Unlike familiar "canned" hypertext help, assistance would be customized and focused to meet the situation at that instant."

PHASE I: Demonstrate the concepts and specify the required capabilities and design of the IPSTA system.

PHASE II: Implement the basic IPSTA capabilities in a fieldable prototype consisting of a set of tools that may be included in application and then generate a demonstration application.

POTENTIAL COMMERCIAL MARKET: Improved system usability and associated increased productivity appeal to both DOD and civilian industry. IPSTA applies to any process that is automated through computer software. Initial examples include software engineering environments and office or business process automation where processes have already been modeled and enacted. Future applications are limitless since all software is essentially an enactment of a process.

AF96-038 TITLE: Transformational Mapping of Formal Specifications onto Parallel Architectures

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop a workstation environment for transforming formal specifications of problems onto parallel processors.

DESCRIPTION: Programming parallel processors continues to be complex and difficult. The various types of parallel processors add additional complexity. Recent progress in transforming formal specifications of a problem into a running sequential program may hold promise to reduce some of the complexity of programming parallel processors.

PHASE I: Demonstrate the computational feasibility of assisting users in programming one specific parallel architecture from the formal specification of a problem. Under user guidance, the system would transform the formal specification into correct and efficient parallel program.

PHASE II: Develop an environment to assist users in mapping formal specifications into programs onto particular parallel architectures. The environment should allow transformation of the formal specification to facilitate the mapping. Users should be able to map the same formal specification to different parallel architectures using a taxonomy of architecture descriptions. This environment would assist the user in transforming formal specifications into provably correct and efficient parallel programs.

POTENTIAL COMMERCIAL MARKET: The ability to map formal specifications onto parallel architectures is applicable throughout the parallel processing community. Specific application areas are the medical, signal processing, and communications areas.

AF96-039 TITLE: Testable Die Carriers

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Provide low cost, high quality multichip modules via design and development of Testable Die Carriers.

DESCRIPTION: To make multichip modules (MCMs) more testable, today's designers must resort to adding in discrete "extra" die to the design. This increases chip area and the probability of assembly defects, while decreasing module speed. The use of Testable Die Carriers (TDCs) provides an innovative 3- dimensional solution for optimally adding testability features to MCMs. Each TDC is basically a silicon logic device, containing embedded circuitry, which supports a single bare die. This effort will identify sizes for two TDCs based on a survey of bare die utilization. Testability macros will be designed for insertion into each family of TDCs. The TDC is a permanent carrier, therefore the testability is used at the die level and in testing the assembled MCM. Boundary Scan would be a requirement. Additional macros could include: PROM/RAM, Ids test sensors, and memory self test, based on the die types included in the TDC family. (A preliminary survey estimates that five sizes of TDC would encompass the large majority of die sizes. The embedded testability will reduce recurring MCM test costs and will allow the use of inexpensive PC- based testers rather than the expensive MCM test equipment currently required. Each TDC will be designed to accommodate dozens of different die sizes, from multiple semiconductor manufacturers. The TDC shall be flexible enough to accommodate a variety of die attachments (Flip-chip, TAB, wire bond). A simple wafer post processing step will be required to mate the standard TDC with a specific die. A thorough reliability assessment of the TDC will be performed; including product evaluation, environmental testing, and failure analysis. Assembly and test will be performed on the die-on-TDC units using different die types and assembly techniques.

PHASE I: Research possible TDC sizes and categorize the included die types. Develop technique to allow TDC to accommodate various die attach methods and design embedded circuitry which can be accommodated in the various TDC sizes.

PHASE II: Design and develop testability macros for inclusion in the TDC. Fabricate TDCs and assemble with the die types determined in Phase I. Develop and implement reliability and performance assessment test plan.

POTENTIAL COMMERCIAL MARKET: High density packaging of electronics is a key element in many commercial and military systems. By using TDCs, MCM designers will reduce the number of discrete die within an MCM, thereby saving in assembly and test costs. TDCs will also allow higher packaging density and significantly improved testability.

AF96-040 TITLE: Testability Insertion For Commercial Off-The-Shelf Parts

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop and test techniques and methodologies for enhancing the testability of inherently untestable commercial off-the-shelf circuits, into an automated CAD tool.

DESCRIPTION: The use of Commercial Off-The-Shelf (COTS) devices in the development of new military systems is being emphasized in order to reduce developmental costs. The significance of the life cycle support cost to military systems requires that the electronics be highly testable. These two requirements are often mutually exclusive. Many COTS devices include little or no Built-In Self Test (BIST) features to allow for the testing of their circuitry. Techniques need to be developed to make these COTS devices testable. This capability has been identified as critical to the ARPA/Tri-Service Rapid Prototyping of Application Specific Signal Processors (RASSP) program. This SBIR effort will develop techniques and methodologies for enhancing the testability of COTS devices. The techniques and methodologies will be qualitatively evaluated to determine their applicability to higher levels of design hierarchy (i.e. MultiChip Modules, boards etc.). Additionally, this effort will develop a prototype commercializable CAD tool, that will allow for the automated insertion of these testability enhancement techniques into board or system designs. The prototype tool will be designed such that it can be integrated into commercial design frameworks.

PHASE I: Research and develop methodologies and techniques for enhancing the testability of commercial off-the-shelf circuits. The various approaches and techniques will be "scoped out" to determine what is necessary to evaluate and initially implement the proposed approaches and techniques. Investigate the feasibility of incorporating the most promising methodologies and techniques into an automated test insertion tool and develop the structure of such a prototype tool.

PHASE II: Implement the approaches and techniques on a set of non-BISTed COTS parts and evaluate the effect they have on improving the testability of the COTS parts with respect to any potential penalties that are incurred. Implement the most promising techniques and methodologies into a prototype, commercializable, automated, test-insertion tool which will have the capability to automatically insert the testability enhancing techniques into board or system designs.

POTENTIAL COMMERCIAL MARKET: This effort is applicable to all board or system designers whose design requirements include testability and that COTS devices be used where appropriate.

AF96-041 TITLE: A Specification Interface for VHSIC Hardware Description Language (VHDL) Designs

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop a method(s) for generating predicate calculus specifications for VHDL designs in a more natural way for Computer Aided Design (CAD) engineers.

DESCRIPTION: Currently, efforts in developing hardware verification technology are focused on the use of predicate calculus. A specification written in a predicate calculus notation can capture the exact meaning of a hardware design and shown to be correct via mathematical reasoning tools or theorem provers. However, the majority of methods developed by researchers around the world use specialized and often difficult to understand mathematical techniques and notations. As such, they are not immediately usable by the typical hardware designer. Rome Laboratory is developing a hardware verification technology based on the VHSIC Hardware Description Language (VHDL). While the design to be verified is coded in a notation familiar to the hardware designer, namely VHDL, the specification of the design still requires the use of a mathematical notation to record the required behavior. While the use of predicate calculus as a specification method is not an insurmountable obstacle, the development of methods for generating predicate calculus specifications of hardware designs in a more natural style to the engineer is desirable. A method of specification (graphic or textual) is to be developed that allows the designer to naturally express the specification of the circuit's behavior. The specification would then be automatically translated to an equivalent predicate calculus specification that can be used directly by a mathematical verification system. This methodology would provide a specification to implementation verification environment via theorem proving and simulation.

PHASE I: Examine the classes of hardware designs to be addressed including simple state machine designs, controller/datapath designs, CPU instruction set design, etc. In each case a method of specification (graphical or textual) would be defined that would allow the designer to naturally express the specification of the circuits behavior.

PHASE II: Implement the approach(es) presented in Phase I.

POTENTIAL COMMERCIAL MARKET: The ability to provide hardware verification is as critical to the commercial developers of Integrated Circuits (IC) as it is to the DOD. Verification technology can reduce IC design time and increase the first pass success rate. Such a saving in time, while increasing the correctness of IC designs, would greatly reduce the cost of IC development and provide a more functionally correct product.

AF96-042 TITLE: Passive Electrostatic Discharge Detector for Integrated Circuits

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop passive techniques for detecting that an integrated circuit that has been "zapped" by electrostatic discharge.

DESCRIPTION: Electrostatic discharge (ESD) has long been known to be a significant problem affecting the reliability of integrated circuits. ESD is caused when a statically-charged object (usually a person) comes in contact with a grounded object. At this time a shock is experienced by both objects. This shock is potentially very damaging to sensitive electronic equipment, especially integrated circuits, since it often represents a pass through of voltages far in excess of the design tolerances. ESD damage on an integrated circuit does not necessarily show up immediately. It can form the nucleus for another failure mechanism and subsequently result in a circuit failure at some future time. Also, ESD damage is related to the severity of the shock event and the number of occurrences of shock events in the circuit's lifetime. Usually ESD events happen totally undetected by the handler of the circuit. Practical means are required for detecting when sensitive electronics has been "Zapped" by ESD. Since the circuit is potentially damaged or degraded during this event, it is in the customer's interest to know of this. The means for detecting the ESD must be passive, or independently powered, in order to detect events during all stages of handling. Successful development of such a technique could be used throughout the entire electronics industry, both military and commercial.

PHASE I: Research and develop candidate techniques for passive detection of ESD events on an integrated circuit.

PHASE II: Prove feasibility of use for the most promising candidate technique(s), and developing working prototype ESD detection means.

POTENTIAL COMMERCIAL MARKET: ESD damage is as much a concern to the commercial market as to the military market. A properly design passive ESD detection technique could be used by all major integrated circuit manufacturers.

AF96-043 TITLE: Integrated Physical Modeling and Analysis of Microelectronics

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop and assess a framework for integrating multiple domain analysis tools for simulating microelectronic devices.

DESCRIPTION: The traditional modeling and simulation approach of defining a physical system in terms of a descriptive set of specifications, dimensions and properties followed by the construction of simplified numerical models for simulating the behavior of that system under some set(s) of natural laws can be cumbersome and prone to error and inefficiencies, both accidental and inherent. This process often involves the use of diverse and separate techniques and tools. The designer is often forced to manage multiple sets of data and computational environments, making such analyses an "after-the- fact" rather than integral part of the design process. Most commercial tool suites capable of multiple types of analyses interface each tool to other tools and/or a central database. A common, integrated approach for managing data representing both the description of a system, and its subsequent analyses is needed in order to automate this analysis process and reduce the overall execution time so where it is feasible to do the analyses during the product design phase. Automatic back-annotation of the physical description with analysis data is necessary along with support for modifying the analysis process based on intermediate results. Such a tool-independent framework can support the accurate and efficient transfer of information between various analysis domains, e.g. thermal, electronic, and electromagnetic. This approach has great potential for supporting comprehensive design optimization. Newly developed analysis techniques could also be easily evaluated and integrated into this framework. The developed framework should provide several distinct capabilities and characteristics: support for different representations of the physical world, e.g. hierarchical, spatial, other; maximum commonality between the computational models associated with the respective analyses; translations of simplifications in one analysis domain to another; selective propagation of changes in the physical model to the various analytical models; incrementally increasing resolution of the models; and communication of analysis results between analysis tools. Application of the framework requires additional research such as: the determination of the best way to represent the physical description of the device; development of a means for deriving one analysis model from another; the assessment of the effect of optimizing multiple design parameters, e.g. functional performance, reliability, cost, etc., on model generation and analysis; and the determination of how tightly the distinct analyses need to be coupled.

PHASE I: Define the framework and demonstrate proof-of-concept. Contrast to existing commercial capabilities.

PHASE II: Integrate three or more existing tools/techniques and demonstrate multiple analyses of a moderately complex microelectronic device design. Assess potential for integration into commercial design practices.

POTENTIAL COMMERCIAL MARKET: All microelectronic device designs involve some form of computer-aided analysis. Development of the above capability will provided the designer the capability to perform extensive analysis in multiple domains during the design phase when the impact of design changes is the most effective and least costly.

AF96-044 TITLE: Development of Time-Domain Planar Near-Field Scanning Measurement Techniques

CATEGORY: Basic Research
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop a new measurement technique to characterize target scattering and antenna radiation over wide bandwidths.

DESCRIPTION: A new measurement technique is described in a two-part publication in the IEEE titled, "Planar Near-Field Scanning in the Time Domain, Part 1: Formulation, and Part 2: Sampling Theorems and Computation Schemes", (IEEE APS, 42, Sep 1994, pps. 1280 ff.). The purpose of this SBIR is to translate the theoretical formulation presented in these papers into a functional, prototype system that can be replicated for use by the antenna and RCS measurement industries/communities.

PHASE I: Develop an approach to implement the new time-domain near-field measurement technique formulated by Dr. Yaghjian and Dr. Thorkild B. Hansen. The best approach will be translated into a preliminary system design.

PHASE II: Finalize the preliminary design completed under Phase I and implement this system. The system will be constructed in the Rome Laboratory's Scattering Chamber located in Ipswich, MA. Near-field scanning equipment and the appropriate time-domain instrumentation that is called for in the final design will be purchased and integrated into a prototype system.

POTENTIAL COMMERCIAL MARKET: Anyone in the business of characterizing antenna radiation and target scattering, particularly over wide bandwidths (short pulse widths) would benefit from this system.

AF96-045 TITLE: Integrated Magneto-Optical Thin Films for Indium Phosphide (InP) Optoelectronic Integrated Circuits (OEICs)

CATEGORY: Basic Research
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Enhance InP-based telecommunications and signal processing optoelectronic integrated circuit functionality through integration of magneto-optic thin films.

DESCRIPTION: The goal of this program is to develop growth, deposition and/or fabrication techniques for integration of transmissive magneto-optical thin films on InP for useful integration with functional OEICs. Magneto-optical (M- O) materials are of interest because of their potential applications in waveguides, isolators, switches, magnetic and electric field sensors, data storage devices, and spatial light modulators. Magneto-optical materials possess unique properties which have already found applicability (in bulk form) in optical systems for use as isolators, waveguides and modulators. To date M-O films on compound semiconducting materials have been limited to reflective films (employing the Kerr effect) rather than transmissive films. Monolithic integration of detectors, lasers, isolators, modulators and waveguides with high speed InP electronics and optoelectronics has obvious advantages with regards to reduced size, weight and assembly cost and time and increased speed and reliability. Integration of M-O materials with these existing optoelectronic structures is expected to expand the functionality of OEICs and provide system level improvements. Optoelectronic isolators and spatial light modulators in particular benefit from on wafer fabrication, that is integration of the modulating elements with the semiconductor laser and control electronics on a single semiconductor wafer. Faraday rotation isolators are commonplace in fiber optical communication networks, and their integration with the SD laser would have size, weight and economic advantages. Regarding SLMs, M-O integration would enable high resolution or small pixel size best fabricated by lithographic means. In each example, integration onto semiconductor substrates benefit not only performance issues but manufacturability concerns.

PHASE I: Experimentally demonstrate M-O/InP material integration and feasibility of integration with OEIC. Efficiency of the Faraday rotation will be evaluated. Material deposition or growth technology will be evaluated with regard to compatibility with foundry OEIC processing.

PHASE II: Develop, demonstrate, characterize and deliver InP-based magneto- optical OEIC. Teaming arrangements such as those between materials growth and device fabrication facilities are encouraged.

POTENTIAL COMMERCIAL MARKET: Magneto-optic thin-film devices will find commercial applications in telecommunications and signal processing where improved optical isolators, switches, modulators and sensors are needed. Indium phosphide based magneto-optic devices have the potential for integration with other devices including diode lasers and detectors used in commercial telecommunications and will provide the same enhanced performance conferred on the military systems.

AF96-046 TITLE: Integrated Surface-Normal Optical Fiber Positioning for Indium Phosphide (InP) Optoelectronic Integrated Circuits (OEICs)

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Enhance InP-based optoelectronic integrated circuit manufacturability through micro-mechanical surface-normal fiber alignment

DESCRIPTION: High data capacity fiber optical communication networks require eventual alignment of fiber ends to detection

elements. Common detectors such as InP-based P-i-N and metal-semiconductor-metal (MSM) photodiodes are designed for surfaces-normal optical input. Cost and availability of assembled fiber-pigtailed detector assemblies are worsened by the optical fiber alignment and attachment manufacturing steps. Although significant advancements have been realized in automated electrical connection technology through wirebonding, tape automated bonding, solder bump bonding and other means, comparatively less advancement has been realized in the area of fiber connections. Newly available processing technologies are expected to facilitate the manufacturability of these surface- normal fiber connections. Micropatterned alignment jigs such as those used for surface parallel fiber alignment, microlens formation, integrated prism couplers, epitaxial lift-off and die attach techniques all present opportunities for fiber alignment technology. The goal of this program is to develop optical fiber alignment and attachment techniques for packaging of discrete and integrated InP-based photodetectors and receivers.

PHASE I: Experimentally develop and demonstrate fiber alignment technology and feasibility of integration with OEIC. Any material deposition, etch, or attachment technology will be evaluated with regard to compatibility with foundry OEIC processing. Market assessment will be made and commercialization plan will be developed.

PHASE II: Develop, demonstrate, characterize and deliver InP-based fiber- pigtailed OEIC. Commercialization plan will be implemented. Teaming arrangements such as those between connector manufacturer, assembly foundry, or materials growth and device fabrication facilities are encouraged.

POTENTIAL COMMERCIAL MARKET: As fiber optics technology is a pervasive throughout the commercial electronic community, better manufacturing of InP optoelectronics through micro-mechanical surface-normal fiber alignment will benefit the entire community.

AF96-047 TITLE: Millimeterwave Components for C3 and improved noise models for CAD

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Command, Control and Communications (C3)

OBJECTIVE: Develop useful millimeter wave components for C3 applications and improve noise models for millimeter wave CAD.

DESCRIPTION: Recent advances in Gallium Arsenides (GaAs) and Indium Phosphide (InP) High Electron Mobility Transistors (HEMTs) have led to high performance monolithic millimeter wave integrated circuits such as low noise amplifiers, power amplifiers, switches and phase shifters. The opportunity now exists to exploit these circuits to realize useful components for command, control and communications (C3) applications such as satellite and terrestrial communications, intelligent vehicle highway systems, data links for robotics control and wideband local area networks. Components operating in the frequency range 50 to 150 GHz should be proposed for the current topic. While these are challenging frequencies requiring significant innovation to exploit, they offer small size and wide bandwidths. Component design should take maximum advantage of unique atmospheric properties such as absorption and transmission bands in order to achieve the goals of the intended application. Maximum use should be made of monolithic circuits and minimum use should be made of wave guide or coaxial parts.

Improved physical modeling of noise processes in the millimeter wave HEMTs used in low noise amplifiers is required in order to take full advantage of the ongoing advances in HEMT technology. The advanced HEMTs use combinations of compound semiconductors arranged in hetero-epitaxial layers to achieve very high gain and very low noise at frequencies through several hundred gigahertz. The goal of the improved noise modeling allows prediction of transistor noise performance given materials properties and devices structure. This effort would require excellent knowledge of semiconductor physics and electromagnetics and would utilize Rome Laboratory in-house experimental HEMT noise measurements.

PHASE I: Identify a component to be developed, the application to be addressed, the individual circuits which will be required, and any anticipated problems. Generate a preliminary design for the component. Demonstrate the feasibility of the modeling concepts.

PHASE II: Fabricate and test a prototype component. Formulate and refine models for incorporation into computer aided design (CAD) software.

POTENTIAL COMMERCIAL MARKET: All of the components envisaged here are inherently dual use. They can contribute equally to the war-fighting capability of the Department of Defense and to the global competitiveness and strength of the U.S. industrial sector.

AF96-048 TITLE: Infrared Imaging Spectrometer

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop a high efficiency, two dimensional infrared imaging spectrometer for short and mid wave applications

DESCRIPTION: An imaging spectrometer constructs a three dimensional image (two spatial and one spectral) from a series of two dimensional images. A standard infrared image contains all spectral components and a way must be found to disperse these onto an imaging focal plane sensor. There are several methods for performing this function (1) use of a series of beam splitters to separate the spectral components, (2) scanned slit, (3) a Fourier transform spectrometer. For several reasons these standard techniques are either inefficient or sensitive to vibrations and not suited to military environments.

This work will try a new approach of using computed tomographic techniques to infrared spectral imaging. The technique uses a rotating direct view prism to place both the spectral and spatial information in the 2D infrared image. It has both high efficiency and tolerance to platform vibration. The method will allow an arbitrary number of spectral bands to be imaged at the desire of the system operator. In operation, the direct view prism disperses the spectrum on the infrared focal plane array. Independent samples are taken by rotating the prism and storing the frame data in a digital computer. The dispersed data are accumulated with over sampling, usually taking at least two samples per desired spectral band. An inversion algorithm is used to reconstruct the separate two dimensional spectral components. The use of this method has been described in recent scientific literature for platinum silicide infrared cameras in the 3.0 to 5.0 micrometer spectrum.

Other spectral bands of interest include the Short Wave Infrared (SWIR) from 1.0 to 3.0 micrometers.

PHASE I: Define and design the 2-D spectrometer.

PHASE II: Fabricate and demonstrate the high efficiency of the 2-D spectrometer using the technique of direct view prism dispersion and reconstruction by inversion algorithms.

POTENTIAL COMMERCIAL MARKET: The military applications include identification of the spectral components of a target or discrimination of camouflage over targets. The commercial uses include remote spectral monitoring of stack effluents and real-time analysis of atmospheric toxins.

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AF96-049 TITLE: Multifunction Phased Arrays

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop affordable phased array antenna technology for future vehicles.

DESCRIPTION: Military, commercial, and private air, ground and sea vehicles of the future will require sophisticated but affordable antennas. Diverse requirements exist in areas such as video, voice, data and fax links, Global Positioning System (GPS) connectivity, surveillance and collision avoidance radar, package tracking, emergency communications and multigigabit per second digital connections. Expected performance will vary from high gain, multielement arrays to low gain, multiple function single elements. Sensor systems will operate in multiple bands within the full microwave spectrum. Digital beam forming, adaptive control and neural networks will lead to more flexible and cheaper sensors for commercial and military systems. These new capabilities include: smart control for array antennas that can sense failures and correct or compensate antenna patterns, super-resolution and neural network techniques that can perform accurate direction finding with smaller systems using less accurate, lower cost components, automatic system calibration based upon the use of available beacons and adaptive cancellation of interference for mobile satellite terminals. These capabilities allow the use of small, low cost radar and communication sensors with increased capability due to the flexibility of adaptive digital smart control. Since most of this

flexibility will be implemented by and under computer control, the development of low-cost, digital beam former modules containing all components from radiating element to A/D converter is key to this initiative. Parallel processing architectures are needed that compete in price and performance with Butler matrices and Rotman lens for programmable, multi-beam systems. The emerging technology of direct digital synthesizers based on fast D/A converters will drive digital beamforming on transmit. The goal is an all digital, neural controlled phased array made affordable by multilayer packaging, reduced cost per function and efficient predictive codes that work to -60dB.

PHASE I: Target a specific antenna application, refine the concept by a thorough theoretical analysis, trade study and error analysis and perform preliminary experiments on key subsystems that will test the overall idea.

PHASE II: Demonstrate the full R-F performance expected by a prototype operating in a realistic environment, and deliver a component, subsystem or full system implementation so as to attract Phase III venture capital with a working prototype.

POTENTIAL COMMERCIAL MARKET: An expanding commercial use of high technology products will include radar and communication capabilities for a variety of portable and mobile systems. Included are mobile links to Global Positioning Satellites, manpack and vehicle mounted satellite links, collision and high data rate links for voice, video, data and fax. These systems will face increasing demands for improved performance while maintaining pressure to continually lower cost.

AF96-050 TITLE: Optoelectronic Silicon Quantum Wells With High Barriers

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Provide silicon quantum well structures for silicon-based near- infrared intersubband lasers, electrooptic modulators and detectors.

DESCRIPTION: Low-cost silicon-based intersubband photonic devices are needed for a host of new Air Force optoelectronic applications. The only system available today is the SiGe/Si system which suffers from a wavelength problem. The SiGe/Si intersubband optical transitions are limited to the middle-infrared wavelengths of 4 to 5 micrometers due to the relatively small band offsets between SiGe quantum wells and Si barriers. A new materials system with large offsets is needed to move Si-based intersubband technology to the shorter wavelengths of 1.3 - 1.6 micrometers for fiber-optical applications. The purpose of this project is to find a practical, manufacturable system of silicon multiple quantum wells in which the crystalline barrier material has a high bandgap of 3.5 eV or more. Epitaxial growth would be used to create the desired nanolayers. Possible means include barriers of cubic ZnS that are lattice-matched to the Si substrate and to the Si quantum wells. Another possibility is to form a superlattice barrier for Si wells, consisting of thin Si alternating with a highly strained monolayer of crystal silicon-dioxide that conforms to the Si lattice. For Phases I and II, a predominantly experimental program is envisioned.

PHASE I: Demonstrate the feasibility of the Si multiple quantum well system by appropriate epitaxy and characterization.

PHASE II: Optimize the Si quantum well system for optoelectronic device fabrication and for commercial production of such wafers.

POTENTIAL COMMERCIAL MARKET: This project could lead to the first silicon- based laser, a device operating in the near infrared at room temperature. In addition, intersubband optical modulators, photodetectors and optical switches could be based upon this work. There would be large commercial payoffs for such components. Another commercial market would exist for highly functional, low-cost optoelectronic silicon chips that combine Si electronics with intersubband photonics. Commercial silicon electronics would also benefit from the proposed high-barrier structures; for example, resonant- tunneling nanoelectronics.

AF96-051 TITLE: Optically Addressed Spatial Light Modulator with Dual Input Subtraction Capability

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Design, fabricate and demonstrate an optically addressed spatial light modulator (OASLM) with dual input subtraction capability.

DESCRIPTION: We desire a binary OASLM where the output is determined by subtracting frames of input data. The application to be used to demonstrate this device is the real time implementation of a binary joint transform corelator (BJTC) using the frame subtraction algorithm. Recent research has shown that this algorithm can improve correlation performance by two orders of magnitude. However, current implementations require the image subtraction to be done in a digital computer and do not operate in real time because of data transfer constraints. By implementing the subtraction in the OASLM hardware, the data transfer bottleneck is removed, and the system can operate much faster. The OASLM should accept two dimensional optical inputs separated in time. The OASLM will be able to store at least one input. The feasibility of also storing a subtraction result to be used as an input should also be investigated. Each input frame should allow multiple exposure inputs to be integrated. A sample and hold capability with multiple exposures per sample is ideal. It is desirable to be able to display the results of one subtraction while collecting new input data. External inputs should allow control of exposure times, data transfer from input to display and threshold level. Either a reflective mode or transmissive mode device is acceptable.

PHASE I: Demonstrate proof-of-concept and fabricate a small scale prototype as the basis device for at least one design implementation.

PHASE II: Fabricate and test a full scale version of the device designed under Phase I. The resolution goal for this device is 256x256 pixels or its equivalent in a nonpixelated device. The device will be demonstrated implementing a real time BJTC which uses the frame subtraction algorithm. This demonstration should have NTSC (television type video) inputs and outputs. Both the demonstration system and a spare OASLM for laboratory use shall be delivered.

POTENTIAL COMMERCIAL MARKET: Real time implementations of the BJTC have applications in manufacturing (robot vision, part location, precision guidance and control), weapons guidance and control, fingerprint identification, building, credit card, and document security, medicine, and other areas. Other applications of this OASLM are in motion detection, automated parts inspection and manufacturing process control.

AF96-052 TITLE: Optical Data Storage and Retrieval

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop optical memory technology to satisfy a variety of mass storage applications emphasizing three dimensional storage applications.

DESCRIPTION: Electronic computing systems exceed the capability of existing data storage systems. To free this processing bottleneck, data storage devices which emphasize high throughput rates (I/O on the order of gigabit/sec) and parallelism as well as high (terabyte) capacity. Consideration will be given to enabling technologies aiding the development of these systems. Current systems being explored face challenges in the areas of dynamic control of two dimensional pages of data as well as dynamic control of holographically encoded data. Methods of controlling data positions and readdressing these encoded data plane are of critical importance to the development of three dimensional optical storage. Proposals to find new three dimensional erasable optical media may be considered for funding as well. For three dimensional optical data storage to become a reality, media must be sensitive to low power laser diodes and retain the data for long periods of time.

PHASE I: Demonstrate the feasibility of the proposed technology concentrating on future insertion of this technology into an optical memory system or the development of the proposed technology into a system of its own.

PHASE II: Design, fabricate and develop a functional model which would address a specific critical area in the development of optical memories.

POTENTIAL COMMERCIAL MARKET: A three dimensional optical memory system with large capacity and high throughput rates would find commercial applications in telecommunication, telemedicine, large database storage and processing and other far reaching applications.

AF96-053 TITLE: Automated Imagery Exploitation

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop a modular automated imagery exploitation capability which can operate across various types of computer

processors and software operating systems including networks of heterogeneous work stations.

DESCRIPTION: Automated (person-in-the-loop) imagery exploitation is required in order to increase the future productivity of Air Force organizations which produce intelligence. This increased productivity will counter the current draw down of personnel strengths and respond to the increasing imagery exploitation workloads. A critical part of this automation is the capability to allow multiple modular computer software packages (tool kits) to function on different computer processors and across different software operating systems. These tool kits provide the imagery exploitation functionality associated with: imagery manipulation (gray value remapping, edge sharpening, color mapping, etc.), measurement, mapping (cartographic) functions and data storage and retrieval. The tool kit approach is very beneficial because it allows for the development of functional capabilities apart from the actual imagery exploitation systems design and development, and allows for upgrades and improvements incorporating the latest and most advanced capabilities. To fully benefit from this approach the tool kits must run across different processors and operating systems and on heterogeneous networks of computer workstations. These configurations are currently the most popular, cost-effective approaches to developing operational imagery exploitation systems. The technical challenge is to develop an approach that will allow for incorporating all existing computer processors and operating systems as well as those currently being introduced or upgraded.

PHASE I: Conduct an exploratory development starting with the use of a single tool kit (government supplied) to demonstrate the proof of concept.

PHASE II: Build a prototype capability to more fully develop and evaluate the concept utilizing multiple tool kits, processors and operating systems.

POTENTIAL COMMERCIAL MARKET: Since many commercial architectures mirror that described above for the imagery exploitation environment, the commercial applications of this technology would be numerous.

AF96-054 TITLE: Intelligent Desktop Computer Assistant

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop an intelligent desktop computer assistant that can automatically generate a standard product.

DESCRIPTION: An Intelligent Desktop Computer Assistant (IDCA) would learn repetitive user computer interactions to generate a standard product that includes text, tables, graphics and video. To generate the product, relevant data will be retrieved from information servers and databases and formatted into a desired product. Currently, users expend much of their time manually finding and retrieving relevant data to build a product in response to a formal request for a specific product. The IDCA would automate the repetitive, manual, time-consuming procedures. Initially, the IDCA would sit in the background and learn the types and sources of data that the user accesses. It will also learn how they translate that data into a final product. After the IDCA has a knowledge base, a formal request would invoke the assistant, the assistant would interpret the request, retrieve the applicable data from heterogeneous sources and translate that data into a rough draft product. It will also be capable of learning user preferences. The assistant will schedule task priorities and deadlines to reflect those preferences. Multiple tasks will be performed in accordance with user assigned priorities. The assistant will adjust the processes by which it interacts with other systems, learning the characteristics of their interfaces as interaction takes place.

PHASE I: Prototype user and system interfaces and identify the learning algorithms required to support both. Develop a mechanism to specify deadlines so tasks can be completed in accordance with user defined priorities.

PHASE II: Implement a fully functional prototype and test it in a controlled environment. Develop a commercialization plan and define the target user base.

POTENTIAL COMMERCIAL MARKET: This capability would be highly useful to any individual with a computer that is connected to any network.

AF96-055 TITLE: Advanced Tools for Information Warfare

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Command, Control and Communications (C3)

OBJECTIVE: Identify, organize and develop emerging information technologies for the denial, exploitation, corruption or destruction of an adversary's information and its functions while protecting own.

DESCRIPTION: This effort spans a number of enabling technologies for attacking, protecting, modeling and communicating information. This effort has the potential for diverse products ranging from innovative hardware or software systems and devices for achieving a new information function, to software tools for accomplishing a structured information function, to a system of signs and symbols to enable a commander to absorb and react to volumes of information that are today beyond human capability.

PHASE I: Define and structure the proposed development in terms of its ultimate military and civilian end products. Rudimentary modeling of the capability in a form suitable for use in wayfaring and DIS (Distributed Interactive Simulation) environments is planned.

PHASE II: Design, fabricate, code and test of a prototype implementation of the proposed capability in context of an operational exercise.

POTENTIAL COMMERCIAL MARKET: This technology is a double-edged sword that could be used both for attacking and protecting information. It is expected that the NII (National Information Infrastructure) will be a burgeoning marketplace for Information Protection technology at the time this development is mature.

AF96-056 TITLE: Intelink Automatic Link Generation

CATEGORY: Basic Research
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop an automated HyperText linking capability for use by INTELINK administrators and intelligence analysts.

DESCRIPTION: Recent interest in the World Wide Web and Mosaic has led to the exponential growth of the Internet. This same technology has been put to use within the Intelligence Community and is known as Intelink. An intelligence analyst's ability to explore the information space on Intelink relies heavily on hyperlinks. This effort will develop techniques for linking separate but related documents automatically for input to a Intelink server.

PHASE I: Develop techniques for linking together separately written but related documents. The techniques used will be demonstrated.

PHASE II: Develop a working prototype which utilizes the techniques developed and provides a useful tool to Intelink administrators and information providers. Hyper Text Markup Language (HTML) will be the format used.

POTENTIAL COMMERCIAL MARKET: This tool can be applied commercially to automatically build links for documents in the 20,000 World Wide Web/Mosaic Servers.

AF96-057 TITLE: Operations Other Than Warfare

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop and apply innovative surveillance technologies to needs of special operations forces and law enforcement organizations.

DESCRIPTION: The vast reservoir of military technology developed during the last 50 years has application to the solution of problems encountered during operations other than warfare by military organizations such as special operations forces (SOF) as well as civilian law enforcement (LE) agencies. At present, these organizations must rely on conventional techniques to accomplish their missions and would benefit greatly from application of more sophisticated technology. Among the technologies potentially available for these applications are systems based on infrared, low-light level television, millimeter wave, microwave, x-ray, and acoustic sensors. Imaging sensors and those which are able to see through walls and clothing are of particular interest. There is a strong connection between sensor and signal processing technology developed for military operations and that needed to support SOF. Employment of this technology in the solution of SOF problems will lead to technology transitions

to civilian LE agencies as a bonus. Applications include concealed weapon detection, wall penetration surveillance, area surveillance and tagging. These sensor systems would be deployed near high value assets such as government buildings, courthouses and secure facilities. Other uses include monitoring the movements of personnel, friendly or otherwise, who might be scattered over a wide area or for detecting movements within buildings during hostage situations. Phase I submissions are solicited which apply these technologies or other similar areas of expertise creatively to the solution of SOF and LE problems.

PHASE I: Propose a technology which will be useful in one or more of the above scenarios and to make quantitative predictions, based on careful analysis and good data, to estimate performance. A conceptual design of a system using this technology will then be developed.

PHASE II: Develop and test a breadboard sensor based on the analysis of Phase I. The outcomes of these tests must include, where appropriate, such parameters as detection probability, false alarm rate, an assessment of the size and weight of the finished product and an estimate of its cost in quantities of 1000 or more.

POTENTIAL COMMERCIAL MARKET: This technology has a wide potential in the area of law enforcement.

AF96-058 TITLE: Photonics Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Command, Control and Communications (C3)

OBJECTIVE: Develop innovative photonic technologies to enhance the performance, availability and affordability of C3I systems and subsystems.

DESCRIPTION: Investigate and develop innovative techniques and technologies in photonics to enhance communications, command and control systems. Develop techniques to apply photonics technologies to systems requirements, especially where conventional techniques fall short of meeting performance goals. Fabricate advanced integrated optoelectronic components compatible with other subsystems for use in operational system designs. Specific areas of interest in photonics technology include optical signal processing, optical computing, holography, photonic materials and devices, optoelectronic devices, high rate analog and digital lasers and detectors, integrated optics, fiber optics, optical switching, optical interconnects, optical data storage and memory, low power nonlinear optics, microwave and millimeter wave optics, optically controlled phased arrays, low noise solid state optical sources, photoemissive devices, multilayer epitaxial III-V semiconductors and nonlinear organic materials. Integration of new technology and required functional developments with on-going and planned operational systems upgrades must be of primary importance.

PHASE I: Conduct a concept definition and experimentation, justifying the technology need and proving the value of the planned approach. Develop a demonstration plan for Phase II.

PHASE II: Fabricate hardware that verifies concept, providing a demonstration of a well defined brassboard level subsystem.

POTENTIAL COMMERCIAL MARKET: Optical pattern recognition for manufacturing; RF-optical systems for cable TV; optical memory for data storage and retrieval systems and video imaging systems; optical processing for automated manufacturing control systems, process control systems and data base management systems.

AF96-059 TITLE: Packaging for Radar Array Electronics

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Command, Control and Communications (C3)

OBJECTIVE: Develop innovative Transmit/Receive module packaging for applications requiring combinations of high heat removal, low weight and low cost.

DESCRIPTION: Currently, radar T/R modules are housed in packages made from aluminum, Kovar, or lightweight alloys designed to achieve particular design constraints. A low microwave frequency module usually requires the removal of large amounts of heat from several bipolar transistor packages and conducts it to a cold plate or coolant. Heat removal and low cost are key issues. A higher frequency module typically uses Gallium Arsenides integrated circuit chips which cover less than half a square centimeter and dissipate less than 1 watt; low weight and temperature coefficient match with the GaAs is

important.

PHASE I: Develop new materials for T/R module packaging based on engineering data on candidate modules supplied by Rome Laboratory/OCSP. Determine the thermal performance and weight and cost differential for retrofitting with improved packaging.

PHASE II: Build a replacement package for the two most opportune modules. Measure the thermal and electrical performance versus the original packages. Rome Laboratory will then install the electronics from original modules into new packages and measure the performance changes.

POTENTIAL COMMERCIAL MARKET: This technology can be commercially applied in the areas of: air traffic control radar, telecommunications, instrument landing systems, cable television systems and global cellular telephone systems.

AF96-060 TITLE: Innovative Module Components for Monostatic & Bistatic Phased Array Radars

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Command, Control and Communications (C3)

OBJECTIVE: Develop innovative receiver and down conversion circuits and components which will result in low power consumption while maintaining high performance circuit operation.

DESCRIPTION: Specific emphasis will be on receiver and down conversion components through the Analog to Digital (A/D) converter. The goal is to reduce power consumption by an order of magnitude while maintaining state-of-the-art noise figures and dynamic ranges. In order to synthesize a receiver subassembly with less than 3 db noise figure and 70 db of spurious free dynamic range, power consumption on the order of 10 of watts is required. From a large surveillance active aperture viewpoint, this is clearly unacceptable since the power consumption of the receiver subsystem could easily consume more power than the transmitter. In addition, the heat transfer requirements for the active aperture would result in a system which may be impossible to implement. Reduction of power consumption by an order of magnitude would correct this problem.

PHASE I: Examine the receiver, down converter, A/D converter subassembly and identify the key high power consumption electronics. Once identified, alternatives to existing designs will be evolved and performance simulated using state-of-the-art computer aided design packages.

PHASE II: Selected components designed in Phase I will be breadboards and performance proved with delivery of the breadboard components.

POTENTIAL COMMERCIAL MARKET: This technology can be commercially applied in the areas of: direct broadcast satellites, global cellular telephone, telecommunications, automotive electronics and wireless local area networks.

AF96-061 TITLE: Space Systems Technology Development

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Air Vehicle/Space Vehicles

OBJECTIVE: Innovative developments for improving performance, endurance and survivability of future advanced space and missile systems.

DESCRIPTION: Advanced space systems need a host of integrated technology developments in order to meet improved performance requirements. We are seeking innovative approaches and technology developments which will provide improved space system performance, endurance and survivability. The proposed approaches should emphasize "dual-use technologies" that clearly will have strong private sector and military applications. Dual-use examples include, but are not limited to High Definition Television (HDTV), advanced communications, energy and environmental conservation or remediation technologies. Proposals prepared and submitted in response to other Phillips Laboratory Space and Missile Technology Directorate (PL/VT) FY96 solicitation topics must not be submitted under this topic; however, proposals applicable to this topic which were prepared in response to topics published by other PL directorates or DoD organizations may be submitted in response to this topic. Specific areas of interest include:

PASSIVE SENSORS: Required are innovative approaches for developing ultraviolet to very long wavelength infrared detectors, readouts, focal planes, and sensors. Innovative concepts dealing with multi-spectral sensors and passive microwave

sounder are needed. Also needed is data fusion, simulation, and integration for improved sensor design and performance.

ACTIVE SENSORS: Innovative approaches in active sensor concepts including LIDAR, RADAR and associated signal processing, signal conditioning, plus related devices and subsystems are needed.

SPACE COMMUNICATIONS: Needed are advanced concepts in space systems communication electronics and developments in antennas, devices and processing for RF, and laser inter-satellite links, plus TT&C systems.

SPACE POWER SYSTEMS: Innovative approaches that will lead to higher specific power at lower cost are needed, specifically: long life, high energy density batteries, advanced solar cell designs, lightweight solar arrays, and power control electronics.

CRYOCOOLERS: We need innovative concepts that will improve the efficiency, reliability and performance of existing designs.

SPACE ELECTRONICS: Innovative approaches in design and development of advanced processors, memory, ASICS, and other electronic devices, packaging technology, micro-electro machines, and micro-electro mechanical devices are desired. Also required are insulated devices and cryogenic electronics.

SPACE SYSTEMS SOFTWARE & SIMULATION: Advanced concepts in reusable software, spacecraft autonomy and spacecraft control and scheduling are needed. Object oriented programming for interactive simulations, hardware in the loop simulation tools, neural networks for enhanced signal, data processing and sensor fusion techniques are needed. Also desired are advanced orbital dynamics and on-orbit simulation tools.

SPACE STRUCTURES: Innovative minimum weight structural concepts are needed that can withstand high-G space launch and ambient environment effects. Active and passive vibration suppression, control, advanced material applications, design and analysis methods are needed.

PHASE I: Develop the concept and perform the necessary analysis required in order to establish the feasibility of a given concept. Develop preliminary plans, designs and possible laboratory scale demonstration.

PHASE II: Complete the initial designs and develop a demonstrator or prototype. Hardware and software developed under both phases shall be deliverable to the Phillips Laboratory upon completion of the Phase II effort.

POTENTIAL COMMERCIAL MARKET: Space systems for DoD and commercial use require advanced technology that is highly reliable, high performance, and is survivable to a variety of man-made and natural environments. These technologies have immediate and definite commercialization potential in consumer goods and infrastructure improvements such as highway safety, environmental monitoring, etc.

AF96-062 TITLE: Radiation Protective Composite Spacecraft Structures

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Air Vehicle/Space Vehicles

OBJECTIVE: Develop new techniques and approaches to satisfy system level spacecraft requirements for radiation shielding using light-weight multi-functional composite structures.

DESCRIPTION: In the ongoing effort to reduce the cost of access to space, a recurrent theme is the use of advanced materials not only to enhance the performance of particular space systems, but also to optimize the efficiency of space operations (i.e. minimize life cycle cost). The focus of this program is the elimination of design constraints that restrict the full implementation of structures. Composite structures are recognized for their superior mechanical performance. However, the structural subsystem is approaching an irreducible minimum of 5% to 10% of the total satellite mass. Further mass reductions must come from innovative system designs that integrate required subsystem interface functions into the structure while using these more efficient materials. Shielding sensitive electronics from space radiation is one such critical issue to resolve when one contemplates lightweight composite shielding to replace the heavier, conventional approach of quarter-inch thick and more of either Aluminum or Tantalum plate which does not protect devices from all types of radiation effects. Until the feasibility of this new technology is demonstrated for electronics enclosures, instrument housings, and battery boxes, minimum-weight spacecraft will remain an unfulfilled future promise. Composite shielding has largely been ignored because it is "known" that PMCs are not only poor shielding materials due to their low atomic weight, but also more expensive than the traditional solution of using metals like Aluminum or Tantalum. The successful development of composite shielding would enable more efficient space assets so that both U.S. industry and the government could more fully exploit the competitive advantages of using affordable, space-based technologies, e.g. in communications, remote sensing, navigation, and meteorology.

PHASE I: Demonstrate advanced shielding concepts to significantly enhance EMI/radiation shielding with composite structures.

PHASE II: Identify one or more layered shield configurations that exhibit sufficient improvement in EMI/radiation protection; build and test sample panels as well as prototype structures to verify results.

POTENTIAL COMMERCIAL MARKET: Radiation protective composites may have significant impacts in the field of commercial aviation, household electronics (RF interference), mobile communications (cellular phones), and commercial spacecraft applications, as well as the geophysical exploration industry (shielded instruments used in the oil field). Other applications may include novel biomedical uses such as new medical devices using radioisotopes for power supplies, therapeutic treatment, or diagnostic elements which would use lightweight biocompatible shielding structures.

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AF96-063 TITLE: Innovative Technologies for Space Extremely High Frequency (EHF) Communications Systems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Command, Control and Communications (C3)

OBJECTIVE: Develop novel technologies for space-based EHF systems

DESCRIPTION: With the rapid increase in the volume of information required to be transferred between space platforms and the earth, new technologies are needed in EHF communication systems to continue to be able to transmit this data effectively, cheaply, and more efficiently. In support of this goal, new and innovative approaches are sought to reduce the cost by reducing the weight, size, and power or the production costs of advanced EHF communication systems. Topics of investigation include three broad areas of research: 1) EHF payload technologies, including, but not limited to alternative payload processing methods; use of MMIC or optical devices for uplink nulling antennas; advanced, multiple beam agile satellite antennas; wideband frequency generation concepts; increasing efficiency of downlink antennas, including transmit phased array antenna concepts; improving weight and efficiency of crosslink subsystems; flexible power combining waveguide to enable multiple traveling wavetube input to be routed to different individual antennas; 2) Airborne EHF terminal, such as thin, lightweight, phased array antennas, including thermal management and scan angle issues; EHF devices for use in solid state power amplifiers or phased array antennas. 3) Other technologies which offer the potential for substantial cost savings in EHF systems.

PHASE I: Develop preliminary designs and perform analysis to select most promising implementation. Hardware concept demonstration is desirable.

PHASE II: Perform laboratory development on prototype hardware to demonstrate the applicability of the selected technique to reduce the cost of deployment of an EHF communication system. The contractor shall deliver all hardware and software developed, document the work performed and develop a plan for transferring the technology to commercial ventures.

POTENTIAL COMMERCIAL MARKET: Increasing commercial emphasis is being placed on global communication systems, as witnessed by such systems as Iridium. Advances in EHF technology can dramatically reduce the costs of such systems, opening entirely new markets in the global communications arena. In addition, there are significant opportunities to "spin-on" commercial technology for direct cost decreases and performance improvements to military MILSATCOM.

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AF96-064 TITLE: New Infrared Focal Plane Array Concepts

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop novel focal plane array architectures for remote sensing, tracking and imaging of targets, and detection and monitoring of airborne pollutants.

DESCRIPTION: The next generation of infrared focal plane arrays for the Air Force must be large-format and high-performance with high data rates and low power dissipation. Spectral sensitivities within ranges between 2 and 12 um, which includes the 3 to 5 um and 8 to 12 um atmospheric transmission windows, will be required with background-limited performance at both low backgrounds (for space-based applications) or high backgrounds (for airborne or terrestrial applications). Formats as large as 1024 by 1024 resolution will be needed with power dissipation less than .5 uW per array element and data rates approaching 500 MHz. Novel concepts for new architectures may include, but are not limited to, monolithic structures and processing, signal conditioning and extraction, multispectral response or spectral agility, and on-array cooling. Future Air Force applications include remote sensing from both air and space, and environmental applications in detection, identification, and tracking of airborne pollution. Commercial applications include monitoring airborne pollution and medical thermography.

PHASE I: Develop preliminary designs and perform analysis to select most promising implementation. Hardware concept demonstration is desirable.

PHASE II: The contractor shall fabricate and test prototype hardware, deliver the hardware and software developed, document the work performed, and develop plans for technology insertion into future systems and commercialization.

POTENTIAL COMMERCIAL MARKET: The technology will be useful commercially for remote detection, identification, and tracking of airborne pollutants emanating from chemical and industrial plants, motorized vehicles, etc. Medical uses include skin thermography for tumor detection and infrared cell sorting.

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AF96-065 TITLE: Anomaly Resolution Using Case-Based and/or Model-Based Reasoning

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Modeling and Simulation (M&S)

OBJECTIVE: Demonstrate how model based and/or cased based reasoning systems can be used to assist a satellite operator in identifying unknown anomalies.

DESCRIPTION: Air Force satellite operators require an accurate and timely method for satellite unknown anomaly determination and resolution. Expert systems provide good tools for known satellite anomalies when knowledge is available. For unknown anomalies, a system must reason based on how the system works (model-based reasoning) and/or on the history of the system (case-based reasoning). Input to the reasoning system is satellite real-time health and status data captured from monitoring satellite telemetry and models of the spacecraft systems. The output is anomaly determination and resolution assistance presented to the satellite operator. What form this assistance takes must be determined, but may include recommendations, schematics, simulations, history, etc. A system would need to be flexible to handle new satellites or changes in a satellite's condition. Computation must be timely to meet real-time requirements of satellite operations. The reasoning system should have verifiable accuracy. The challenge is to develop a case-based and/or model-based reasoning system suitable for satellite real-time operations.

PHASE I: Address whether model-based and/or case-based reasoning is best suited for unknown anomaly resolution, how it should be implemented into a satellite control system, and how accuracy is verified. Provide a demonstration using a subset of a satellite subsystem.

PHASE II: Provide a prototype demonstration on an entire satellite on-board subsystem.

POTENTIAL COMMERCIAL MARKET: Potential application for this technology includes DoD, NASA, and commercial satellite ground stations. Other applications include process control such as automobile manufacturing, nuclear power, and robotics.

REFERENCES:
1. Phillips Laboratory. USAF Phillips Laboratory SBIR Software Engineering Guide. 1995. (Contact Phillips Laboratory, PL/VTQ, 3550 Aberdeen Ave SE, Kirtland AFB, NM 87117-5776; telephone (505) 846-0817; email address: anderson@plk.af.mil for a copy.)
2. Change, C.P., et al. "Satellite diagnostics system: an expert system for INTELSAT satellite operations", ESA, Launch Bases and Control Infrastructures for Spacecraft. Oct 91. pp 321-327.
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AF96-066 TITLE: Enhancing Satellite Operations Through Increased Space Automation

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop and demonstrate innovative software method to increase space automation, thereby enhancing satellite ground operations.

DESCRIPTION: USAF satellite ground operations are both labor intensive and costly. In addition, the training time required to bring an operator up to the appropriate skill level is lengthy. An increased number of Air Force satellites are scheduled to go on orbit in the coming years, while at the same time downsizing will result in fewer operators being available to operate these satellites. A number of efforts are underway to increase automation of Air Force satellite operations from the ground perspective. The goal of this topic is to develop and demonstrate innovative software methods to increase automation of satellites from a space perspective thereby enhancing ground operations. Emphasis is placed on how automation can be moved from the ground to space. The challenge for the innovator is to be able to increase automation of satellites that are currently on orbit.

PHASE I: Provide a detailed description and design of the proposed method for enhancing satellite operations from the space perspective. Details will include particular satellite subsystems to be enhanced, satellite programs to be utilized, proposed hardware and software development platforms, software development methodologies, as well as any necessary ground interaction with the automated space segment. Details should also be provided as to the proposed method for integrating the developed software into existing satellite systems.

PHASE II: Develop a working prototype of the system and implement a proof-of-concept demonstration. Perform system analysis to determine the performance benefits of the technology when utilized with automated ground systems. Cost, time, and manpower savings shall quantified.

POTENTIAL COMMERCIAL MARKET: Increased automation of satellites and reduction of operations and maintenance costs is of interest to virtually every organization that operates satellites. Potential applications include Navy, NASA, and commercial

satellites. In addition, there is potential for use of the technology in other space missions such as future NASA shuttle flights.

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AF96-067 TITLE: Space Power Components

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Air Vehicle/Space Vehicles

OBJECTIVE: Develop innovative and lightweight power generation, management, distribution, and/or storage technologies for space systems.

DESCRIPTION: In order to provide space-based capabilities at lower cost, space vehicle power system mass and volume must be reduced while improving electrical performance. Proposals should address advanced components, including energy sources (solar photons or non-standard), energy conversion (conversion efficiency >= 35%), arrays, PMAD (power management & distribution), batteries, or non-electrochemical energy storage. Technologies must have mass production potential as well as significant improvements over state-of-the-art.

PHASE I: Produce the conceptual design of one or more power systems and identify materials of construction, interface requirements, thermodynamic characteristics, development status, and life limiting mechanisms. Proof of concept is required. A clear path to a Phase II should be established.

PHASE II: In Phase II, the contractor shall develop a working prototype of the component being addressed. The prototype should be able to fully demonstrate the benefits of the proposed technology. In addition, the contractor shall perform system analysis to determine the performance of the technology in comparison with established space power systems.

POTENTIAL COMMERCIAL MARKET: In Phase III, the prototype could be further developed to meet the specifications for a particular application as to power, mass, volume, temperatures, efficiency, cost, and manufacturability. Potential applications of the power system and associated technologies developed by this effort include DoD, NASA, and commercial satellites as primary and secondary power sources, and terrestrial power systems, including co-generation applications. For example, the components developed under this effort could enable remote power, portable electronics (e.g. phones or computers), or electric vehicles. Each of these areas has civilian markets projected to greatly expand in the near future.

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AF96-068 TITLE: High Power Density Electronics Thermal Control

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop and demonstrate innovative technology for assuring long-term thermal control of SoA high-power density electronics in spacecraft.

DESCRIPTION: Miniaturization of electronics in recent years has made it possible to package electronics in a more power-dense manner. This trend has created a situation of more and more power generated per specific area, and thus more heat is generated because of this increased power generation. The trend is manifesting itself in space systems where size and weight reduction is important, but the technology for thermal management has not kept pace. Many terrestrial solutions exist, but have limited application in space. Thermal management is fast becoming the limiting factor of operating power in space electronics. The situation is also promoting larger radiator surfaces, and thus larger satellites. There is an extreme need for state of the art thermal management technology advances, assuring long term thermal control commensurate with increasing heat generation from state of the art high power density electronics packaging. The challenge for the innovator is to combine performance, reliability, durability, and affordability into one system at acceptable risk.

PHASE I: Produce the conceptual design of one or more thermal management systems, identifying thermodynamic characteristics of heat dissipation, material for construction, interface requirements, development status, and life limiting mechanisms.

PHASE II: Develop a working prototype of a thermal management system as a proof-of-principle device. It is desirable that this approach be demonstrated in conjunction with the PL Advanced Packaging Thermal Management Testbed which can provide empirical verification of performance. The contractor shall also perform system analysis to determine the performance of the technology in comparison with established spacecraft high power density electronics thermal management systems.

POTENTIAL COMMERCIAL MARKET: Phase III could further develop the prototype to meet the specifications for a particular application as to power, mass, volume, temperatures, efficiency, cost, and producibility. Potential applications of the high power density electronics thermal control system and associated technologies can readily be found in the growing commercial satellite market, as well as the obvious military and NASA uses. Since packaging is a fast growing commercial area, many applications ranging from lap-top computers to medical instrumentation are promising. Considering the general trend toward the smaller satellite, the potential market for successful high power density electronics thermal control systems and associated technologies is large.

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AF96-069 TITLE: Radiation-Tolerant Microelectronic Device Development

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop novel techniques to produce radiation-tolerant microelectronic devices for space applications.

DESCRIPTION: Most contemporary microelectronic devices used in the Air Force space systems are obtained from radiation hardened fabrication facilities. The technologies employed in fabricating these devices were developed to protect

microelectronics exposed to nuclear weapons environments and exceed the requirements for many space applications. The costs of such devices are extraordinary and dramatically increase the cost of space assets that use them. Although the optimum cost and performance can be obtained by using commercially available devices, those devices typically degrade rapidly in the space radiation environment. In Phase I, the effort will focus on identifying novel design approaches and/or fabrication techniques that will yield radiation-tolerant (i.e., operate at mission-defined specification after up to 200 Krad [Si] total ionizing dose) microelectronic devices at reduced costs. Any approach that appreciably reduces the cost of microelectronic devices designed to survive in space radiation environments will be seriously considered. Some possible topic areas are: modified commercial fabrication processes, novel design and layout approaches, redesign of commercial devices, radiation shielding, or a combination of any of these.

PHASE I: Identify and develop novel design and/or fabrication techniques that yield radiation-tolerant microelectronic devices at reduced cost.

PHASE II: Demonstrate that the selected approach will yield devices that are producible and that meet the Phase I design specifications.

POTENTIAL COMMERCIAL MARKET: Every government and commercial organization that will place a system in space will benefit from the cost reductions that will result from this effort. Furthermore, future microelectronic devices (i.e., those with very small feature size) operating on the Earth will be susceptible to single event upset (this has been observed in the most advanced technologies available today). Therefore, the techniques developed in this effort that will avoid single event phenomena will benefit the entire microelectronics industry and its consumers.

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AF96-070 TITLE: Space-Qualifiable, Non-Hermetic Packaging

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop an electronics packaging method to qualify for space missions without the need for hermeticity.

DESCRIPTION: Putting vehicles into space has many restrictions and constraints because of the harsh space environment. To comply with the restrictions and ensure a successful mission, electronics have been required to be packaged in hermetic, ceramic packages to prevent outgassing, and to prevent moisture from being introduced into the circuitry prior to launch. The high cost of space missions can be partly attributed to the cost of special electronics packaging to insure hermeticity of electronic components. If a packaging method or strategy can be developed to allow the electronics to be qualified for space missions without the added expense of hermetic ceramic packaging, the possibility of reducing the cost, size, and weight of electronics can be realized readily.

PHASE I: Provide the conceptual design of the package or strategy to include all modeling and simulations of environmental testing. If a strategy is developed, then a simulation must be required to demonstrate the viability of the procedures to be space qualified. If a package is designed, then a model of the prototype should be developed and run against a simulated space environment to demonstrate the ability to maintain operations under the constraints of space environment.

PHASE II: Develop a working prototype and demonstrate the ability to maintain operations under the constraints of space environment. Provide analysis of the package or strategy under simulated and actual test scenarios outlined in MIL STD 883.

POTENTIAL COMMERCIAL MARKET: If the results of Phase II are successful, the packaging effort or strategy can be employed by any microelectronics vendor to provide electronic components or circuits for use in space missions.

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AF96-071 TITLE: Advanced Spacecraft Mechanisms

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Air Vehicle/Space Vehicles

OBJECTIVE: Develop advanced spacecraft mechanisms to replace motor-actuated devices.

DESCRIPTION: A broad spectrum of motor-actuated mechanisms are used in space and commercial applications. Recent advances in shape memory alloys such as NiTiNOL and terfinol have made this technology available for use in advanced components that replace pyrotechnics and motor-actuated devices. NiTiNOL release devices to replace pyrotechnics have been under development for several years. NiTiNOL is now being considered for a large number of motor-actuated deployment arms, gimbals, latching and positioning mechanisms, etc. NiTiNOL works by applying heat to expand the metal so that it takes a new form. When it cools, it returns to its original form. NiTiNOL mechanisms are extremely simple to build and operate and have dramatic advantages over motor-actuated devices. Reliability is much greater since there are no internal moving parts. Several alternatives to shape memory alloy devices for replacing motors include electrostrictive and magnetostrictive devices. All non-motor device technologies are to be considered in the design of the advanced mechanisms.

PHASE I: Investigate candidate spacecraft and commercial devices to be replaced by advanced mechanisms. Identify mechanisms with the highest pay-off potential using smart mechanism alternatives based upon reduced cost, weight and power, and upon improved performance and reliability. Develop smart mechanism(s) and design and demonstrate feasibility of the unit(s).

PHASE II: Complete unit development and fabricate the smart mechanism(s). Demonstrate performance pay-off of the unit(s) based upon test data.

POTENTIAL COMMERCIAL MARKET: A vast array of industrial, automotive, and aircraft actuating mechanisms are motorized and can be replaced by advanced mechanisms that are much easier to fabricate and achieve far greater reliability than motors. These units can also provide dramatic reductions in cost, weight, and power.

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AF96-072 TITLE: Conformable Integrated Circuits

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop lightweight, thin, low power, highly reliable conformable (moldable) integrated circuits for use in computer, aerospace, and communication systems.

DESCRIPTION: As electronic circuits become more and more complex and the physical component size becomes smaller, the ability to develop integrated circuits that are ultra-thin exists. The majority of the bulk of the IC is based on physical support, not circuit volume. Thinning of wafers and bulk material has reduced the weight and size substantially; however, with the new technologies that exist, the circuit can literally be lifted off of the wafers leaving just the bulk of the circuit itself. After the circuits have been removed, they can be stacked in a plywood manner and increase the circuit density much more than is realized today, as well as giving physical integrity to the device.

PHASE I: Provide a conceptual analysis of the feasibility of a circuit lift-off process followed by a description of a stacking or multi-layered process to increase the density. Provide some physical examples of a circuit or circuits of choice, complete with the ability for a standard acceptable I/O interface.

PHASE II: Develop a working prototype and demonstrate the use of the process as well as provide a working model of at least three layers of circuit in the aforementioned stacking configuration.

POTENTIAL COMMERCIAL MARKET: If the results of Phase II are successful, the devices will provide manufacturers with the ability to provide smaller, faster, lighter, less costly electronic components to the DoD and the public sector. The applications are virtually limitless: communications, radar, computer systems, etc.

AF96-073 TITLE: Lightweight, Magnetic Suspended Reaction Wheels

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop lightweight, magnetic suspended reaction wheels for attitude control applications.

DESCRIPTION: The Air Force has identified a need for lightweight, magnetic suspended reaction wheels for advanced space-based attitude control applications. The design goals shall include increasing the rotational speed by a factor of ten, decreasing average power consumption requirements by a factor of two, decreasing component weight by 50% and increasing overall component life to >20 years over current reaction wheel systems. The Phillips Laboratory is seeking innovative concepts for the design, analysis, fabrication and test of a lightweight, magnetic suspended reaction wheel for small satellite concepts.

PHASE I: Develop a preliminary design of a lightweight, magnetic suspended reaction wheel system and demonstrate the concept feasibility for meeting the requirements provided in this topic description.

PHASE II: Finalize the Phase I design. Develop or fabricate the lightweight, magnetic suspended reaction wheel system prototype. Conduct in-depth testing and analysis leading to the possible flight test prior to contract completion.

POTENTIAL COMMERCIAL MARKET: This technology has applications to all three axis stabilized commercial satellites and may have a profound impact on programs such as IRIDIUM and TELEDESIC. In addition, the magnetic bearing technology has spin off applications in the area of momentum energy storage devices. Excess energy generated by power plants at night could be stored in large magnetic suspended momentum devices and could be retrieved during peak daylight hours.

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AF96-074 TITLE: Launch Isolation System for Reusable Launch Vehicle Containerized Payload Systems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Air Vehicle/Space Vehicles

OBJECTIVE: Develop and demonstrate a launch isolation system for reusable launch vehicle containerized payload systems.

DESCRIPTION: The Air Force is seeking innovative concepts for payload isolation applicable to the containerized payload systems that are advocated for use on reusable launch vehicles (RLVs). The launch isolation concepts may be passive, active or an active/passive hybrid design. Proposals must demonstrate an understanding of the launch isolation problem, design and analysis methodology, validation of the methodology, and adaptive or "tunable" performance to accommodate a range of payloads. Although not required, the Phillips Laboratory (PL) encourages small businesses to team with a potential RLV manufacturer to ensure that all design issues are adequately addressed.

PHASE I: Based on the proposed concept, develop a preliminary launch isolation system design. Demonstrate the design feasibility through analysis and laboratory experiments.

PHASE II: Finalize the Phase I design. Develop a launch isolation system prototype and conduct in-depth testing leading to a possible flight test prior to contract completion.

POTENTIAL COMMERCIAL MARKET: This technology has commercial applications for the ground and air transportation of shock sensitive materials or equipment. Examples may include the development of isolated transport dollies for explosives, ground handling fixtures for satellites, and isolated container systems for air and ground transport.

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AF96-075 TITLE: Thermally Conductive Vibration Isolation System for Cryocoolers

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Air Vehicle/Space Vehicles

OBJECTIVE: Design and develop an innovative thermally conductive vibration isolation system for cryocoolers.

DESCRIPTION: Current cryocoolers impart residual imbalance forces which induce optical line of sight jitter and image degradation. The Phillips Laboratory (PL) is seeking innovative solutions to provide a thermally conductive vibration isolation system for a cryocooler. The isolation system should provide at least a 20:1 narrowband vibration reduction at the cryocooler's primary operating frequency. Additionally, the isolation must provide a passive means to allow the cryocooler to remove sufficient heat from the camera/cryocooler system to maintain optimum mission performance.

PHASE I: Based on the proposed concept and analysis, develop a preliminary design of a thermally conductive vibration isolation system for cryocoolers. Demonstrate the design feasibility through analysis and/or laboratory experimentation.

PHASE II: Finalize the Phase I design. Develop a prototype thermally conductive vibration isolation system for a cryocooler and conduct in-depth testing and analysis leading to the possible flight test prior to contract completion.

POTENTIAL COMMERCIAL MARKET: This technology has applications to any type of vibrating machinery which must be isolated but still be able to transfer heat loads. Examples include refrigeration compressor systems or precision machining heads where the vibration generated by the moving part must be attenuated, but waste heat must be removed to ensure the survivability of the component. Other space applications include isolation critical electrical components where it is essential to form a strong thermal connection in order to remove waste heat.

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AF96-076 TITLE: Attenuation of Acoustic Disturbances in Expendable Launch Vehicle Payload Fairings

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Air Vehicle/Space Vehicles

OBJECTIVE: Develop an innovative approach for the attenuation of acoustic disturbances in payload fairings.

DESCRIPTION: The Air Force is seeking novel innovative concepts for the attenuation of acoustic disturbances in payload fairings generated by the launch environment of an expendable launch vehicle (ELV). Concepts should emphasize minimum weight, volume and power and if an active system is proposed, impact on the launch vehicle. Any active system must also address electromagnetic interference (EMI) issues, and potential interaction with launch vehicle control systems. Although not required, the Phillips Laboratory (PL) encourages the small business to team with a potential ELV manufacturer to ensure that all design issues are adequately addressed.

PHASE I: Develop an innovative design for the attenuation of acoustic disturbances in ELV payload fairings. Demonstrate the design feasibility through laboratory experiments and possibly, modeling.

PHASE II: Complete the Phase I design and fabricate a full-scale prototype. Conduct in-depth testing and analysis leading to the possible flight tests prior to contract completion.

POTENTIAL COMMERCIAL MARKET: This technology has applications in any market that would benefit from a non-intrusive, lightweight, low cost method of attenuating acoustic disturbances. A few commercial examples include automobiles, air conditioners, and dishwashers.

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AF96-077 TITLE: Distributed Object Management Environment for Improving Space Mission Fault Tolerance

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop advanced capability to improve space mission fault-tolerance by supporting the flexible configuration and reconfiguration of distributed space services.

DESCRIPTION: Space-based resources have wide ranging capabilities and must operate in noisy, long delay environments. It is important to improve sharing of distributed space services by supporting the flexible configuration and reconfiguration of distributed services. A Distributed Object Management Environment (DOME) is a strong technology candidate for providing the ability to "intelligently" auto-configure/reconfigure space/ground assets to support space mission control. There are several commercial DOMEs available, but none have developed an adequate internal knowledge base (called an operations information base) and communication primitives to support sophisticated auto-configuration/reconfiguration, and protocol negotiation for greater fault-tolerance. A critical need exists for an advanced DOME to enhance the functionality of future satellite systems.

PHASE I: The Joint NASA/DoD Space Communications Protocol Standards Technical Working Group (SCPS-TWG) is working on developing an implementation-neutral specification to standardizing command and control of spacecraft and supporting ground networks. The contractor will become actively involved in the SCPS-TWG efforts to make sure the proposed specification, including the underlying protocols and control infrastructure, will support configuration/reconfiguration support such as protocol negotiation. The contractor will develop an Operation Information Base (OIB) prototype that will support identified configuration/ reconfiguration scenarios.

PHASE II: The contractor will develop DOM primitives needed to perform protocol negotiation and advanced auto-configuration using the operational information base. The contractor will work with commercial DOME vendors (preferably CORBA compliant) to see how an advanced configuration/reconfiguration capability to improve space mission fault-tolerance can be implemented within the DOME internally or as a layered product. The contractor will develop extensions to the DOME to demonstrate the configuration/ reconfiguration capability.

POTENTIAL COMMERCIAL MARKET: Although commercial DOMEs exist, extensions to the DOME technology will improve the fault-tolerant capabilities of distributed object management systems in a space/ground mission control environment. There is strong dual use potential because DOMEs are beginning to be used in the management of commercial satellites.

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AF96-078 TITLE: Resettable, Lightweight Bypass Switch for Battery Cells

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop a resettable, lightweight bypass switch for battery cells to minimize the weight of batteries and power system electronics.

DESCRIPTION: Present battery systems allocate a large fraction of weight for redundant capacity and protection against open circuit battery failure. The redundant capacity can be in the form of either a redundant battery (composed of a number of cells connected in series) in parallel with the other batteries or redundant cell(s) in a battery. Use of cell rather than battery redundancy can significantly reduce the weight of a battery system, but usually requires the use of cell bypass to prevent an open circuited cell from causing open-circuit battery failure (a single-point failure without battery redundancy). A high-current, lightweight, resettable cell bypass switch is needed to save weight over the use of present high-current diode and relay systems which also require high heat dissipation. Weight savings would be due to lower device weight and lower thermal dissipation requirements. The switch would be resettable by command to provide battery management flexibility in response to anomalous or degraded conditions. The switch design should be scalable over the 20 to 200 Amp range with maximum weight density of 0.8 gm/Amp. The working conditions are -15 to 35 degrees C and operable in space for 15 years. Materials used in the switch need to be space qualified.

PHASE I: A design for switches meeting the above requirements will be completed and documented. Six (6) prototype switches will be built, three (3) with 200 Amp capability and three (3) with 20 Amp capability. Tests to demonstrate weight, current capability, and resettability will be completed and reported. A plan to qualify switches for space operation under working conditions for fifteen (15) years will be submitted.

PHASE II: One hundred (100), fifty (50) 200 Amp capability and fifty (50) 20 Amp capability, flight-type switches will be built and tested. The switches will meet all above requirements. Sufficient testing to qualify switches for space operation for 15 years will be completed and reported. The test procedures require Air Force approval prior to testing.

POTENTIAL COMMERCIAL MARKET: The switch will be in high demand for both DoD and commercial space application and should be readily usable readily usable for non-space DoD or commercial applications.

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AF96-079 TITLE: Smart/Adaptive Structures using Thin-Film Shape Memory Alloys

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop a smart/adaptive composite structure with embedded thin-film shape memory alloy actuators to adjust structure's dynamic characteristics/shape.

DESCRIPTION: Adaptive structures, also called smart structures and materials, refer to the various materials systems which automatically or remotely alter their dynamic characteristics or geometry to meet their intended performance. Smart materials consist of a structural component such as fiber reinforced resin composites with distributed sensors and actuator and a microprocessor. A variety of sensors and actuators have been employed: piezoelectric, ferroelectric, magneto restrictive, ferrofluids, and shape memory alloys. The shape memory alloys have ben successfully demonstrated as embedded actuators in composite materials. The usual form of such actuators has been as wires. However, there are limitations imposed by shape memory wires, some of which are poor bonding between the wire and the matrix, poor heat transfer during cooling, and generation of "kinks" in the composite lay-up. Thin films of shape memory alloys would be better suited for composite smart structures, giving enhanced fatigue properties and rapid thermal cycling responses. The intent of this program is to address the technical challenges to produce thin-film shape memory actuators for smart composite materials, while assuring that the thin film form of the shape memory alloys maintains or enhances the desirable physical and mechanical properties compared to shape memory wires. A demonstration of the thin film manufacturing hardware will be required.

PHASE I: The contractor will define the basic concepts of smart structures with shape memory thin-film actuators, including the selection of the proper thin film manufacturing processes and the shape memory alloy compositions to be used.

PHASE II: The production and the full characterization of the shape memory films will be followed by composite manufacturing process development. a prototype production smart structure will be fabricated and the vibration control and the shape changing capabilities characterized.

POTENTIAL COMMERCIAL MARKET: Smart structures can be used in various space structures such as mirrors, antennas, robotic booms, etc. for commercial as well as military space programs. They can also be used in aircraft and domestic ground transportation systems to control noise and vibrations.

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AF96-080 TITLE: Metal Matrix Joining Techniques

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop and demonstrate high strength, non-outgassing joining techniques for continuous fiber reinforced aluminum metal matrix composite structural components.

DESCRIPTION: Continuous fiber reinforced aluminum metal matrix composites hold significant promise in the development of extremely lightweight, high stiffness, non-outgassing primary and secondary structures for spacecraft. Recent testing has also demonstrated that structures fabricated from these materials provide enhanced survivability characteristics when subjected to high rates of energy deposition from lasers. Unfortunately, the use of conventional joining techniques such as adhesive bonding, mechanical fasteners, soldering, and low temperature brazing either result in outgassing contaminants, damage to the reinforcing fibers, or less than optimal joint strength. Innovative solutions for joining techniques that allow designers to take maximum advantage of the high strength and stiffness properties of these materials is required.

PHASE I: The contractor will identify a candidate joining technique applicable to continuous fiber reinforced aluminum metal matrix composites. Limited coupon testing will be performed to demonstrate the potential for the candidate joining technique to provide joints with high stiffness and strength.

PHASE II: The contractor will provide additional coupon testing and a laboratory bench demonstration of the joining

technique on a simple representative structural test article. The test article will be structurally tested for strength and stiffness to demonstrate suitability of the joining technique to provide a full strength bond.

POTENTIAL COMMERCIAL MARKET: The high stiffness and strength properties of continuous fiber reinforced aluminum metal matrix composites have potential application in the commercial satellite and aircraft industries. The development and demonstration of improved joining techniques will increase the potential for commercial exploitation of this advanced composite material.

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AF96-081 TITLE: Telemetry Front-End Using PC-Based Systems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop an innovative PC-based, real-time data acquisition system that will enhance satellite telemetry analysis.

DESCRIPTION: The Front-End component of the Satellite Control System is a real-time data acquisition system. A Front-End usually possesses a highly customized graphical user interface (GUI), complex telemetry processing set-up, limited networking capability, limited remote operation capability, and specific operating system requirements. Other drawbacks are an inability to process both frame and packet formatted telemetry, and an inability to process multiple streams on one PC. These factors make purchasing and developing Satellite Control Systems with commercially available Front-Ends expensive and relatively inflexible. The challenge is to develop a PC-based Front-End for a satellite telemetry analysis system without the above limiting factors, and whose operation can be integrated into a larger satellite control application.

PHASE I: Produce a conceptual design of a PC-based Front-End including hardware and software. Identify capabilities, limitations, and interface requirements. Design a prototype demonstration for Phase II.

PHASE II: The contractor shall develop and prototype a working system.

POTENTIAL COMMERCIAL MARKET: Potential applications for this technology include DoD, NASA, and commercial satellite ground stations. Other application areas include electrical power production, oil refineries, and automated factories.

REFERENCES:
Phillips Laboratory. USAF Phillips Laboratory SBIR Software Engineering Guide. 1995. (Contact Phillips Laboratory, PL/VTQ, 3550 Aberdeen Ave SE, Kirtland AFB, NM 87117-5776; telephone (505) 846-0817; email address: anderson@plk.af.mil for a copy.)

AF96-082 TITLE: Electromagnetic Effects, Measurements, Protection, Sources, and Satellite Protection

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop high power electromagnetic or Radio Frequency (RF) sources, components, measurement techniques for electronic systems, and produce new methods for addressing threat phenomena to satellites.

DESCRIPTION: The Phillips Laboratory is in need of new and innovative approaches in the development and demonstration of compact, lightweight, RF sources for both weapons and commercial applications. The technology sought should address sources capable of delivering gigawatt levels of power in microsecond or shorter pulses. Both narrow and wide band sources are of interest. The technologies that may be addressed in this effort include pulsed power, high power microwave tubes, transmission lines, converters, and antennas. Also of interest are methods and techniques for measuring the performance of these components, the effects that such environments will have on electronic systems, and methods of protecting systems from electromagnet environments over a wide range of frequencies and field levels. Protection against electromagnetic effects with the increased use of electronics, lower power semiconductors with reduced noise immunity thresholds, reduced shielding through increased use of plastics and composite materials, and increased RF emissions will be critical for both military and commercial systems of the future. The increased use of Commercial-Off-The-Shelf (COTS) equipment in military systems will also require improved protection approaches for future systems. Application of electromagnetic technologies for other areas such as security systems, law enforcement, medicine, and information systems are also of interest. In addition to the application of electromagnetic protection to satellites, additional protection is needed for other threat environments such as radiation, thruster firings, space debris, orbit dependent chemical reactions with naturally occurring species, and solar or laser radiation. Many of these environments are natural or occur during normal operations, but others may be threats faced by satellites during a war time situation. Reliance on commercial satellites for future military functions is likely to increase and reliable, survivable satellites are a must for both peace time and possible war time conditions. Additional technologies of interest include high energy plasma production, measurement, and applications.

PHASE I: Feasibility experiments and demonstrations will be conducted. A proposed schedule for implementing the proposed approach, specific commercial applications, and possible market partners will be included in the final report. Commercial partners committed to Phase II support is desired.

PHASE II: Develop and implement the Phase I approach or preliminary design, producing a prototype model, device, and/or process which must be demonstrated to be effective either at full operation or scaled to laboratory bench parameters. Prototypes developed during Phase II will be delivered to the PL in operating order with sufficient documentation to allow for validation testing. Identification and commitment of commercial partners, (if not accomplished in Phase I) shall be pursued. A viable private sector marketing approach must be developed and implemented.

POTENTIAL COMMERCIAL MARKET: Many of the necessary technologies required for military weapons and systems have similar commercial applications. The high power sources and antennas can be used to locate and identify buried unexploded ordinance needed in base clean up efforts. Other technologies associated with ultra wide band sources can be used to improve airport and other security systems operating at lower power levels commensurate with personnel safety. Protection of future electronic systems is a must in a society with ever increasing dependency on reliable operation of automobiles with airbag, anti skid brakes, electronic transmissions and steering, fly-by-wire aircraft, information highway systems, and home appliances to mention a few. Increased use and dependency on satellites for everything from communications, global position systems for commercial aircraft, weather, and many other applications combined with the high cost and difficulty of repair require that these systems be designed to protect them from threat environments both during normal operation and in case of war time to protect our interests in the world of the future.

AF96-083 TITLE: Biomedical Engineering Applications of Microwave Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Biomedical

OBJECTIVE: Develop biomedical applications of microwave technology for medical diagnostics and treatment.

DESCRIPTION: Low level microwave fields combined with active sensors can provide a potential method of complementing existing x-ray, ultrasound, and magnetic resonance imaging techniques to extend medical diagnostics. Combined with computer aided tomography, low level microwave fields can provide an alternate method of gathering data concerning diseased tissue or abnormalities in the body. Highly collimated fields can be used to focus on specific areas of the body without exposing surrounding tissue. A sensor array can provide the necessary spatial and time varying data to present a tomographical display of the area under investigation. Electromagnetic radiation may also provide a method of selective heating areas of the body of hypothermia cases, activate localized medical treatments, perform non-evasive surgery, disinfect, and dispose of medical waste.

Data Processing and analysis techniques such as the Singularity Expansion Method (SEM) may allow improved analysis of medical tests such as ECGs, etc. Higher band width instrumentation and sensors may also provide more information for better

diagnostics. Computer automation of these signal analysis techniques combined with automated correlation methods could speed up medial diagnostics, transmission of data, and treatment, especially for remote or understaffed facilities.

Phase I, II, or III proposals which involve or are expected to involve animals or human testing must be submitted to the Phillips Laboratory along with protocols prepared in accordance with the prescribed DoD format and, if available, pertinent certifications.

PHASE I: Utilizing Phillips Laboratory electromagnetic technology, establish the basic feasibility of the proposed application and perform investigations necessary to determine specific approaches, identify critical development requirements, potential risks, and provide a basis for determining the potential success of a Phase II effort. The proposed Phase I effort shall not involve any animal or human testing. However, if Phase II plans will involve or lead to animal or human testing, the Phillips Laboratory will require delivery of th "protocols" within 3 months within 3 months after Phase I contract award.

PHASE II: Develop and fabricate a prototype system, conduct laboratory and other tests which will demonstrate a capability with clear commercial potential. Develop commercial partnership interests for a Phase III production and marketing program. Phase II contracts involving any animal or human testing will require additional data deliverables (such as the "Annual Report to the Surgeon General) documenting all animals or human testing.

POTENTIAL COMMERCIAL MARKET: The civilian sector has similar requirements in the areas of medical diagnostics and medical treatments. Remote medical data collection, analysis, and transmission requirements are common for both battlefield environments and small communities without full medical support.

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AF96-084 TITLE: Analog Fiber-Optic Link With 10 GHz Bandwidth

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronic Warfare/Directed Energy Weapon

OBJECTIVE: Develop field useable, fiber-optic information links which transmit and receive signals with a modulation frequency of 10 GHz and beyond.

DESCRIPTION: There is recurring requirement in both the military and commercial sectors to accurately determine the effects of an incident, electromagnetic field on the operation of a piece or a set of sensitive electronics. The process of measuring

electrical current and voltage responses at particular points within electrical systems or subsystems requires that the desired information be transmitted from the measurement point to a suitable recording device. It has long been known that adding an electrically conducting wire or cable will likely change the electrical characteristics of the quantity being measured. The presence of additional conductors changes the electromagnetic topology of a particular configuration, and the effect becomes more pronounced as the frequency of the incident radiation increases. In measurements in nuclear electromagnetic pulse simulators and in microwave measurements up to 1 GHz, it has been common to use specialized, analog fiber-optic (F-O) transmit/receive links to connect the measurement point with the data recording device. The current capability of field-worthy F-O links with useful signal-to-noise ratios (SNR) is 1 GHz (signal is 3 dB down). More experimental units with increasingly poor SNRs claim to work up to the neighborhood of 10 GHz. A great amount of microwave response measurements are currently being made between 1 and 10 GHz. It is expected that more interest will be displayed in the 10-20 GHz band in the near future. There is an increasing requirement for a field-worthy F-O link that will accurately transmit analog data at frequencies between 1 and 20 GHz. Such a link must accept standard microwave connectors and must be reasonably small in size such that it does not greatly impair the validity of the measurement being made.

PHASE I: A successful effort would result in the design and development of a laboratory-scale prototype device that demonstrates that there are no physics principles blocking development. Address technical issues that have constrained the development of practical F-O links above 1 GHz. These issues may be related to physics, (e.g., there must be electro-optical sources such as LEDs or lasers that can be effectively modulated at the required frequency), or they may be engineering related such as temperature and vibration effects or poor signal-to-noise ratio.

PHASE II: Demonstrate that a F-O link can be constructed or fabricated which meets the performance standards agreed upon as a result of the Phase I effort. The link must be capable of delivering useful performance and must be able to be used in the field under realistic, trying conditions. The F-O link will have to be able to manufactured at a reasonable price to offer a real opportunity for widespread application.

POTENTIAL COMMERCIAL MARKET: Fiber-optic links are already used in many commercial applications because of their wide bandwidth and their relative immunity to electromagnetic interference. Many of these F-O links are digital, but there are many applications where an analog capability is preferred. An analog bandwidth of 10 GHz may attract a number of users in the communication field or any field where recording or moving wide-bandwidth data is necessary.

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AF96-085 TITLE: Advanced Rocket Propulsion Technologies

CATEGORY: Basic Research
DOD TECHNOLOGIES: Aerospace Propulsion and Power

OBJECTIVE: Develop innovative components, manufacturing and processing techniques, and integration technologies aimed at doubling existing rocket propulsion capabilities by the year 2010.

DESCRIPTION: There is a need for novel, innovative approaches in the development of technologies which can double existing rocket propulsion capability by the year 2010. These revolutionary concepts, based on sound scientific and engineering principles, are essential in order to increase performance and mission capability while either retaining or decreasing life-cycle costs. Specifically, technological goals include: the 80% reduction of environmental hazards from propellant ingredients and processing, propulsion exhaust, and rocket motors while either maintaining or surpassing current propulsion efficiency, increasing the payload capability of existing launch and upper stage propulsion systems by 7%, a 50% decrease in the cost and time of manufacturing of solid rocket motors, increasing the service life of cryogenic liquid rocket engines between overhauls from 3 to 100 flights, reducing the number of parts for a cryogenic turbopump by 80%, integrating high energy density matter into future rocket propulsion systems, and advancing rocket propulsion capabilities through concerted government and industry based advances in Integrated High Pay-off Rocket Propulsion Technology (IHPRPT) efforts. Improvements in the operability, reliability, maintainability, and affordability of space launch applications, for example, might include development of novel

systems which can be launched with short lead times for a relatively low life-cycle cost. Such systems would need to demonstrate high metrics in reliability and maintainability. Subsets of advanced rocket technologies would have lengthy shredouts of potential research subjects but are not stated here in detail. These technologies might include the need for combustion and plume diagnostics (i.e. application of electro-optical devices and sensors), performance predictions, modeling of exhaust plume radiation and combustion characterization, propellant and component service life prediction technologies, and environmental contamination. Furthermore, bold, new advanced/non-conventional propulsion and related technological concepts and products for space activities are solicited for development. These topics include revolutionary concepts in very advanced fuels and oxidizers, metastable high energy nuclear states, storage of antimatter in chemical matrices, nanotechnology products and techniques, enigmatic energy devices, and field propulsion thrusters. Research in these advanced rocket propulsion topics are included and structured to provide a maximum of innovative flexibility while yielding promising commercial applications/dual-use technologies to prospective investigators.

PHASE I: The initial research in the effort will assess existing capabilities and demonstrate, through bench scale evaluation of the proposed new approach, the payoff to be derived by implementing the concept.

PHASE II: Phase II will demonstrate selected advanced rocket technological concepts beyond bench scale and conduct verification testing of those concepts.

POTENTIAL COMMERCIAL MARKET: Advanced rocket propulsion technologies will transition to the US commercial space launch industry, thus enabling the US industry to more favorably compete with foreign sources for space launch opportunities through reducing the life-cycle cost of inserting payloads to space orbit. Advanced rocket propulsion technologies also serve the commercial sector by enhancing our ability in remanufacture and maintenance of the US ballistic missile fleet.

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AF96-086 TITLE: Electro-Optic Devices for Rapid and/or In-situ Combustion Measurements

CATEGORY: Basic Research
DOD TECHNOLOGIES: Aerospace Propulsion and Power
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop and demonstrate innovative electro-optic based detection techniques for measuring transient and steady state propellant combustion products.

DESCRIPTION: Although widely used in research, wide application of chemical species specific laser based optical measurements has typically been stymied by some combination of their large size, complexity, high cost, inability to operate in uncontrolled environments, pulse repetition rate, etc. Recent progress in electro-optics technology suggests that most, or all, of these deficiencies can be overcome, and that full realization of the potential inherent in optical techniques is immanent (e.g., visible diode lasers capable of producing picosecond pulses at GHz repetition rates and a solid state photomultiplier (PMT) with excellent temporal resolution and a 10 6 improvement in dynamic range over the conventional dynode PMT are currently available). Innovative electro-optics developments have wide applicability in both defense and industrial applications. For example, the development cycle and cost for new energetic fuel additives and advanced propulsion hardware could be significantly reduced if the benefits of laboratory sized laser- based optical diagnostics were available in rugged, compact form. This capability could be designed into propulsion devices at the prototype stage to provide in-situ optimization of fuel mixture ratio, detection of abnormal ablation, and monitoring of exhaust pollutants. Other innovative developments could enable the small scale combustion testing of tiny amounts of advanced energetic materials; for instance by providing in-situ/on-the-fly kinetics determinations for a single transient event. In summary, innovative applications are desired for electro-optic devices of any type in conjunction with novel signal processing strategies which result in miniaturized optical spectroscopic hardware applicable to in-situ steady state or highly time-resolved propellant combustion product analysis.

PHASE I: Techniques to improve measurement of gaseous species in hostile and transient environments as related to combustion products and toxic and polluting materials associated with AF propulsion should be evaluated in the SBIR proposal as part of the choice of the offeror's approach. Strategies which result in faster measurements and lower limits of detection while significantly reducing the size and complexity of the system are of particular interest. A proof of concept demonstration is required.

PHASE II: Develop and demonstrate a prototype of the electro-optic measurement technique explored in Phase 1. In either case, all hardware and software developed shall be delivered, and a well documented plan for technology insertion into

USAF systems and into commercial applications shall be prepared.

POTENTIAL COMMERCIAL MARKET: Low cost, rugged, electro-optic based measurement techniques could be widely applied throughout DoD to optimize and control propulsive combustion devices and to monitor their operation and emissions. Similarly, this technology could be applied to automobile, diesel and marine internal combustion engines. Their low cost would also facilitate use in industrial applications for monitoring stack emissions from power plants and chemical manufacturing plants to name only two of an almost unlimited range of possible applications. Another characteristic of some electro-optic devices is the ability to operate on a picosecond time scale. When coupled with appropriate data acquisition approaches, the SBIR methodology could lead to the ability to measure chemical events that are currently too fast to be measured or observed. This type of fundamental knowledge could lead to the development of new highly energetic propellants, new materials, new "designer" molecules for any number of purposes, etc.

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AF96-087 TITLE: Electric propulsion thruster for low power small satellites

CATEGORY: Basic Research
DOD TECHNOLOGIES: Aerospace Propulsion and Power

OBJECTIVE: Develop and validate innovative design concepts for low power electric propulsion thrusters applicable to small satellites.

DESCRIPTION: Electric propulsion thrusters can achieve on-orbit maneuvering and stationkeeping capabilities that more than double chemically based systems. Further benefits are anticipated as technology is advanced; the objective of this effort is to radically push the technological envelope in the field of electric propulsion. Proposed concepts must show promise of more efficiently utilizing the on-board electrical energy to enhance the delivered specific impulse to the propellant. Projects proposing enhancements to existing systems will also be considered. Applicability of innovative propulsion concepts to small satellites (500 lbm down to less than 10 lbm) is a new area of interest to the Air Force, and overall thruster system density (delivered thrust/ overall propulsion system mass) is of critical concern for these smaller satellites. For phase I efforts, a strong emphasis should be placed on the validation of the design that is expected to provide the stated performance enhancements; experimental and theoretical methods can be considered. Government and commercial test and evaluation facilities may be utilized; documentation of efforts to secure these facilities should be provided. Based on the results of these tests, thruster performance should be estimated and improvements quantified.

PHASE I: Develop and validate innovative electric propulsion thruster concepts for small satellite (500 lbm to 10 lbm) applications: primary interests are performance, thrust to weight ratio, minimal impact on spacecraft operations and systems, minimal spacecraft contamination, environmental compatibility, and lifetime. The focus of the effort should be on stationkeeping and orbit maneuvering applications.

PHASE II: Apply the results of Phase I to the design, fabrication, experimental validation, and optimization of EP thruster performance capabilities. The design process is expected to be iterative with the thruster with the best overall performance being reproduced and delivered at the end of the phase II effort.

POTENTIAL COMMERCIAL MARKET: The development of smaller satellites, and their propulsion systems, is one avenue for reducing satellite launch costs. Dual use commercialization would occur through the development of flight quality electric propulsion systems for satellite and space experiment applications. Both mission capability and profitability will increase through the introduction of these thrusters into the marketplace. The outlook for commercialization therefore appears quite favorable.

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AF96-088 TITLE: Electric propulsion thruster materials for on-orbit applications

CATEGORY: Basic Research
DOD TECHNOLOGIES: Aerospace Propulsion and Power

OBJECTIVE: Improve the thermal and mechanical properties of electric propulsion thruster materials.

DESCRIPTION: Electric propulsion thrusters can achieve on-orbit maneuvering and station keeping capabilities that more than double those of chemically based systems. With an electric system, substantially greater amounts of energy can be deposited in the flow. The performance of these devices increases as more energy is added to the flow, but is finally limited by thruster material properties and system energy loss mechanisms. The improvement in the material properties of key thruster components should result in performance, reliability and life benefits. Example components are: arcjet insulators and electrodes, hall thruster insulators, and ion engine grids. The goal of this SBIR effort is to develop and validate electric propulsion materials with improved thermal and mechanical properties. Strong emphasis should be placed on near term application of the results to both the military and commercial satellite propulsion. For Phase I, a strong emphasis should be placed on the identification and testing of the EP materials expected to provide the stated capability enhancements; testing should, as accurately as possible, reflect the environment of the material during thruster operation. Government and commercial test and evaluation facilities may be utilized; documentation of efforts to secure these facilities should be provided. Based on the results of these tests, thruster performance should be estimated and improvements quantified.

PHASE I: Develop and validate electric propulsion thruster materials resulting in performance capabilities significantly exceeding those of existing EP devices: primary interests are performance, minimal impact on spacecraft operations and systems, minimal spacecraft contamination, environmental compatibility, and lifetime. The focus of the effort should be on the near term applications of station-keeping and on-orbit maneuvering.

PHASE II: Apply the results of Phase I to the design, fabrication, experimental validation, and optimization of EP thruster performance capabilities. The design process is expected to be iterative with the thruster with the best overall performance being reproduced and be deliverable at the end of the phase II period.

POTENTIAL COMMERCIAL MARKET: Dual use commercialization would occur through the development of flight quality electric propulsion systems for satellite and space experiment applications. Improved electric propulsion thrusters will extend mission lifetime, increase spacecraft maneuverability and reduce system mass. Both mission capability and profitability will increase through the introduction of these thrusters into the marketplace.

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AF96-089 TITLE: Environmental Approaches to Solid Propulsion Technology

CATEGORY: Basic Research
DOD TECHNOLOGIES: Aerospace Propulsion and Power
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop environmentally advanced approaches to solid propulsion technology that will assure full compliance with present and impending environmental legislation.

DESCRIPTION: Increases in environmental restrictions affect production, test, mission, and disposal of Air Force systems using rocket propulsion. To remain in compliance with existing and impending regulations (such as Executive Order 12856 and the National Emission Standard for Hazardous Air Pollutants for rocket testing to be enacted in the year 2000) new approaches, materials, and processes have to be developed. This will include new components (fuel or oxidizer) for environmentally acceptable solid rocket propellant which confer higher performance (specific impulse and density impulse) than current solid propulsion systems. This includes the development of innovative solid propellant compositions which transcend current propellant and motor production approaches to obtain more environmentally acceptable exhaust. Environmental enhancement of exhaust includes reducing particulate matter, oxides of nitrogen, oxides of carbon, and acid, (Current approaches use either an additive to combine and neutralize chlorine from perchlorate oxidizer or substitute nitrate-based oxidizer for the perchlorate). Novel, environmentally enhanced approaches to hazardous waste streams from solid propellant and motor production (e.g., volatile organic cleaning solvent, waste water, toxic curatives), testing, and disposal (air pollutants from open burn/open detonation of scrap propellant) are sought.

PHASE I: The contractor shall identify and evaluate environmentally acceptable technologies in terms of : 1) the ability to reduce or eliminate hazardous waste streams from production, testing, and disposal; 2) effectiveness in preventing the release of toxic species into the environment; 3) the ability to replace potentially restricted ingredients in solid rocket propellant with higher performing, environmentally enhanced ingredients; 4) the ability to comply with current and projected environmental regulations; 5) impact on motor performances; and 6) expected life cycle costs of implementing the technologies.

PHASE II: The contractor shall use the technologies identified in Phase I to produce a test motor of up to 800 lbs. for static firing. The emphasis will be on validating the environmental acceptability of the technologies at this larger scale and substantiating the performance of the test motor.

POTENTIAL COMMERCIAL MARKET: Under the Federal Facilities Act of 1992 all federal installations must comply with the same environmental regulations as private, industrial concerns. Consequently, the environmental technology developed in producing, processing, testing, and disposing of propellant will be transferable to related commercial sectors. Commercial space ventures are in need of environmentally advanced propulsion systems to meet future regulations and restrictions. Similarly, related energetic materials industries (i.e., pyrotechnics and explosives) could benefit from the technology developed in this program. Capability as a form, fit, and function for a specified system as predicted in Phase I will be of high value, not only to the military, but to commercial space ventures as well.

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AF96-090 TITLE: Low Cost, Non-Eroding Nozzles

CATEGORY: Basic Research
DOD TECHNOLOGIES: Aerospace Propulsion and Power
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop an environmentally safe, innovative, low cost technology to produce non-eroding nozzles for use in solid and hybrid rockets.

DESCRIPTION: The nozzle of a solid or hybrid rocket motor experiences an extreme operating environment. The gases exiting the rocket motor chamber move at supersonic speeds through the nozzle while at temperatures of thousands of degrees Kelvin. The gas often consists of particles such as metal oxides. All of these factors combine to erode the nozzle, especially in the area of the throat. This erosion leads to loss of motor performance. Various approaches have been tried to keep nozzle erosion to a minimum. PAN was used but its manufacture has been discontinued due to environmental concern. Various phenolic and other ablative materials have been used, but a less eroding solution is desired. High quality carbon parts have been produced and used. These nozzles perform well but suffer from high manufacturing cost. The Air Force needs an environmentally safe, innovative, and low cost technology to produce non-eroding nozzles for use in solid and hybrid rockets. The technology should be applicable to nozzles of tactical size to boosters.

PHASE I: The researchers shall define the design requirements for nozzles to perform Air Force missions. The contractor shall develop a technique for manufacturing nozzle materials in laboratory scale quantities that meet requirements yet show promise of low manufacturing cost. Finally, specimens of the candidate material will be prepared and tested for suitability in a nozzle application.

PHASE II: The contractor will fabricate tactical size rocket nozzles. These nozzles will be tested in an environment as similar as possible to a rocket motor firing and will be evaluated as to how well they resisted erosion. Comparisons of the performance of this material combination will be made to conventional nozzles.

POTENTIAL COMMERCIAL MARKET: The results of this research should find application in various commercial systems. There is a continuing need for structures that can withstand high temperatures as well as mechanical loads. This technology will be useful in such areas as aircraft structures, machinery, and power plants.

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AF96-091 TITLE: Solar Thermal Rocket Propulsion

CATEGORY: Basic Research
DOD TECHNOLOGIES: Aerospace Propulsion and Power

OBJECTIVE:Develop novel solar thermal propulsion components

DESCRIPTION: The solar thermal rocket propulsion concept is to develop an Orbital Transfer Vehicle (OTV) to boost payloads from low earth orbit to geosynchronous equatorial orbit. This rocket has a theoretical capability of inserting into higher orbits, about twice the payload of current OTVs and will be reusable. The OTV consists of two energy collecting and focusing concentrators which direct sunlight into two small apertures. Within the apertures, are heat exchanging mediums, through which hydrogen gas, our propellant, flows. The hydrogen picks up heat, expands, and thrust is produced out the propulsive nozzle. For our missions, we must keep the package volume and weight of the OTV to a minimum. This means using thin film inflatable concentrators and structural supports as much as possible. They are made of thin film polyimide and are shaped like clamshells or balloons, depending on the type. Both types have a clear light transmission area and a reflectorized light collection area. Micrometeoroids can penetrate the thin film materials easily, leaving larger holes upon exit than on entrance. The concentrator's useful life will be of longer time duration if they can patch themselves instead of having to be replaced every other mission or so. Other components required for the solar rocket include but are not limited to: concentrators, thrusters, energy storage/propulsion bi-modal systems, propellant tankage, space sun-trackers, optical quality measurement devices, and laser beam power thrusters. The latest technologies in Solar Thermal Propulsion concentrator components deal with focusing laser light into apertures from ground-based systems; developing, designing and fabricating foam inflation/rigidized structures for supports; and composite material telescoping supports that are lightweight, package-able in small volumes, and self-deployable. For thrusters, the newest ideas are: Matrices of small tubes that act like black body cavity receivers; and working, shaping, and applying new methods of manufacture to high temperature exotic refractory materials for use as solar absorbers.

PHASE I: Generate a list of methods; analyze them and perform tradeoffs analysis. Some of the factors include but are not limited to the following: Usefulness in space, effectiveness in closing holes or at least reducing the size (self-repairing concentrators), cost effectiveness, ease of use, environmental concerns, autonomy, distortion of the focal image, reliability, maintainability, vulnerability, and survivability. Develop preliminary designs and perform analyses to select most promising candidate. Laboratory demonstration of the selected concept is preferred but not required.

PHASE II: Further develop, design, fabricate, and demonstrate the chosen Phase I design/concept. The contractor shall deliver any hardware/software developed, document the work performed and develop a plan for technology transition and insertion into future systems and other commercial ventures.

POTENTIAL COMMERCIAL MARKET: The systems developed under this program will ne useful for many civilian applications. The high temperature refractory materials can be used for nuclear plower plant applications. The concentrator work can be transitioned into space based or terrestrial antennas. The self-repairing methods may transition into automobile/motorcycle/bicycle repair and hot air balloon repair, besides the aforementioned areas. The optical measurement systems can be used on telescopes, etc., before and after deployment in space to determine suitability.

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AF96-092 TITLE: Advanced Propulsion Technology and Products

CATEGORY: Basic Research
DOD TECHNOLOGIES: Aerospace Propulsion and Power

OBJECTIVE: Develop bold, new advanced/non-conventional propulsion and related technological concepts and products for space activities.

DESCRIPTION: The identification and development of advanced propulsion concepts and new technologies strengthens the American economy and is fundamental to the continued effectiveness of the United States Air Force as a military entity. As new concepts and technologies lead to the evolution of improved military capabilities, new dimensions are added to strategies and operations. Bold, new advanced/non-conventional propulsion and related technological concepts and products for the Air Force's space activities are solicited for development. Very advanced fuels and oxidizers, high energy density materials including metastable nuclear states, storage of antimatter in chemical matrices, nanotechnology products and techniques, capability enhancing computer programs, enigmatic energy devices, and field propulsion thrusters are typical examples of the desired propulsion technology to increase performance, reduce cost, be environmentally safe, and improve reliability and operability. Particular attention will be given to revolutionary concepts based on sound scientific and engineering principles offering quantum increases in performance and/or mission capability while at the same time yielding promising commercial applications. Thus, the emphasis will be on dual-use technologies for both commercial and military rocket propulsion applications. Studies and surveys are not desired. What is wanted are new, revolutionary concepts and technologies that can be developed to a sufficient degree to demonstrate their readiness for applications in both the private and government sectors of the economy. Programs should be logical and well planned. Statements of work presented in Phase I proposals should be complete and detailed in task by task statements with accompanying bargraph schedules and adequate financial visibility.

PHASE I: Identify approaches, procedures, tests/experiments, analysis, and establish a conceptual design. Plans, costs, and schedules should be accomplished, and critical experiments and analyses should be performed in order to provide baseline data for Phase II.

PHASE II: Phase II will be a developmental effort in which a technology is significantly advanced or a product is evolved and delivered.

POTENTIAL COMMERCIAL MARKET: The results of a successful Phase II development would lead to an advanced, high performance, low cost rocket propulsion systems, enhanced analysis capability, or related technology that could be used for both military and commercial applications.

AF96-093 TITLE: Laser Initiated Ordnance System (LIOS) Development

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Laser, Optics & Power Systems

OBJECTIVE: Develop a fail-safe solid state ordnance firing system using semiconductor laser diode technology to replace conventional electro-explosive devices.

DESCRIPTION: Laser initiated ordnance systems (LIOSs) can be state-of-the-art solid state replacements for the present day electrically initiated ordnance firing circuits employed in commercial and military space launch vehicles. They can eliminate

the need for electro-mechanical safe and arm devices and mechanical latching relays that are used in today's ordnance firing circuits. The LIOS also eliminates the conventional electroexplosive device (EED) which is sensitive to premature initiation from radio frequency, electromagnetic and electrostatic environments.

Commercial and military space launch vehicles and satellites use explosively initiated devices to effect numerous events from lift-off to orbit. These explosives devices are electrically initiated by way of electro-mechanical switching networks. A typical launch vehicle and satellite uses at least 70 explosively initiated events to get into proper orbit. The majority of these are redundant; therefore, 80 explosive initiations can occur from engine ignition and lift-off to final appendage deployments in orbit. At the extreme, NASA's space shuttle uses more than 400 explosive events from lift-off through deployment and release of their drag parachute on landing.

Today's technological advances indicate that upgrading existing systems to use solid state control circuits and laser initiated explosive devices can enhance performance and effect cost savings. These savings will result from the safety improvements, streamlined operational flow, weight reductions, and improved reliability of this new technology. This effort will engineer, develop, and qualify a LIOS concept, proving that this technology advancement is viable.

PHASE I: Analyze Air Force furnished, existing electrical circuit designs and, based on this analysis, develop new concepts that are fail-safe and incorporate Built-in-Test (BIT) features. The Phase I objective is to prove analytically that solid state technology can satisfy safety and reliability requirements without increasing system complexity. Elimination of mechanical components, assuring fail-safe circuit designs, and providing remote health check capabilities are the key elements of this task. A demonstration of design concepts will afford insight into probability of Phase II success.

PHASE II: Phase I concepts will be fabricated as a prototype system and tested to validate that fail-safe and BIT requirements are met. Testing must include environmental exposures and operational constraints. Performance margins must be established. From this, performance and requirements specifications shall be developed.

POTENTIAL COMMERCIAL MARKET: The LIOS concept is applicable to all operations that presently use electro-explosive devices. These include mining, oil exploration, demolition, law enforcement, military applications, and space vehicles. All will benefit from the safety improvements a LIOS will yield.

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AF96-094 TITLE: <u>Environmentally Acceptable Propellants for Satellite On-Orbit Functions</u>

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Effects

OBJECTIVE: Develop environmentally acceptable ODC and VOC free replacements for hydrazine fuels and oxidizers used for long life satellite on-orbit functions.

DESCRIPTION: The Montreal Protocol and the U.S. Environmental Protection Agency mandate the reduction and eventual elimination of many ozone depleting compounds (ODCs) and volatile organic compounds (VOCs). These prohibited ODCs and VOCs were selected on the basis of potential health and/or environmental hazard. Hydrazine (N2H4), monomethylhydrazine (MMH), unsymmetrical dimethylhydrazine (UDMH) and nitrogen tetroxide (N2O4) are used as propellants in both DoD and commercial propulsion systems. The hydrazine based fuels are highly toxic and hazardous materials, i.e., the above mentioned are volatile and are classified as carcinogens. Dissociation products of N2O4, i.e., NO2 are ODCs. In connection with launch vehicles, these propellants will be eventually eliminated and replaced by ODC/VOC free liquid oxygen/kerosene or liquid oxygen/liquid hydrogen. These fuels must also be replaced in satellites. The replacement propellants for long term satellite usage must be capable of long term stable storage on-orbit and provide required functions on demand throughout the satellite life time. Both hydrogen peroxide (H2O2) and ammonia (NH3) have been used as monopropellants. The dissociation products of these propellants are clean, i.e., hydrogen (H2), nitrogen (N2), and water (H2O). The use of electrically augmented thrusters with H2O2 or HN3 as bipropellants with or without electrically augmented thrusters may produce thrust equivalent to that of N2O4/MMH.

PHASE I: Phase I will include: 1) a thorough review of the existing propellants that have been developed and used on previous programs; 2) the requirements for ODC/VOC free propellant replacement will be analyzed; 3) existing propellants meeting the requirements will be selected and analyzed for feasibility; 4) if no existing propellants meet the ODC/VOC free requirement, other desirable products will be identified.

PHASE II: The contractor will develop thrusters and demonstrate by test the feasibility of the selected propellants. If new propellants are identified, Phase II activity will need to develop the production processes for the replacement propellants.

POTENTIAL COMMERCIAL MARKET: Selection of ODC/VOC free replacements for N2H4, MMH, UDMH, and N2O4 from existing/new propellants will reduce the cost of DoD and commercial satellite system operations. Additionally, the cost for waste disposal will be reduced. Hazardous atmospheric pollutants will also be reduced.

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AF96-095 TITLE: Evaluation of Environmental Effects on GPS Navigation Systems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Air Vehicle/Space Vehicles

OBJECTIVE: Develop technology to assess environmental effects impact on the performance of Global Positioning System (GPS) navigation systems and design techniques improving operational capabilities.

DESCRIPTION: The widespread and increasing utilization of the Global Positioning System (GPS) for navigation and positional information requires improved knowledge of GPS receiver systems' vulnerability to a wide range of environmental effects. L-band signal amplitude fluctuations induced by electron density structures in the ionosphere may exceed 20dB under severe conditions; substantial phase scintillations have also been observed. To assess the impact of these fluctuations on the integrity of GPS positional data, a flexible, robust receiving system capable of monitoring both carrier signal strength and differential phase, as well as computing GPS based navigation solutions, is needed. The requirement for determining scintillation levels for individual satellite links demands that the system be able to digitally record carrier signal strength and differential phase for each satellite in the field of view at relatively high sample rates (-50 Hz) with sufficient sensitivity and dynamic range to provide the maximum receiver grade margins for both GPS frequencies (L1 & L2). Positional information derived from the GPS data must also be recorded. The recorded data should be accessible via a standard network interface for real-time analysis and display. This system will be utilized in several field locations to monitor the severity of ionospheric effects on GPS navigation systems under a variety of operating conditions, particularly near equatorial and polar regions and during magnetically disturbed periods.

PHASE I: Phase I efforts will develop a diagnostic concept and produce a prototype receiver system meeting the robust requirements described above. The system shall be suitable for conducting field measurements designed to evaluate the performance of GPS systems under various operational environments.

PHASE II: Phase II will produce cost-effective hardware/software implementations to both recognize and assess the severity of environmentally-induced performance degradation and adaptively improve navigation systems' capabilities under unfavorable conditions.

POTENTIAL COMMERCIAL MARKET: In addition to addressing military requirements for secure, reliable navigation and

positional information under essentially all operating conditions, the systems developed under this program have obvious direct application to the global civilian market for GPS navigation. Recent certification of GPS technology for visual flight rules (VFR) navigation by the Federal Aviation Administration and pending approval for use as an instrument flight rules (IFR) nav-aid insure that GPS will be relied on heavily for navigation and applications requiring accurate positional information (both military and civilian) for the foreseeable future. The multi-billion dollar transportation industry, particularly for applications near equatorial and polar regions, will benefit tremendously from the systems development and evaluation activities proposed under this SBIR solicitation. Data obtained under this effort will also contribute directly to the evaluation of communication systems in this frequency band (L), including both government and commercial satellite-based telecommunications for the military and civilian sectors, respectively.

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AF96-096 TITLE: Optical Sensors for Geophysical Remote Sensing, Environmental Monitoring and Target Characterization

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop innovative visible/infrared remote-sensing instrumentation for geophysical research, environmental and target characterization.

DESCRIPTION: The Air Force conducts geophysical research to gain further understanding of the environment between the earth and the sun and to determine its effect on Air Force systems and operations. The Air Force also has the responsibility to measure the effect of Air force operations on the environment. Phillips Laboratory has developed a variety of advanced remote-sensing instrumentation to aid in these efforts, but is interested in new sensors that leverage recent progress in commercial technology. Examples include passive optical systems such as visible or infrared radiometers, spectrometers, and imaging spectrometers. Many commercial technologies such as those in detector arrays, electronics, and data storage and processing are emerging that could be developed into innovative systems for remote sensing of the geophysical environment. The instrumentation will be utilized in ground-based, airborne, and space applications. Specific instrumentation of interest include: imaging spectrometers, which simultaneously obtain both spatial and spectral characteristics of a background or target; imaging multispectral radiometers which measure the spatial and temporal characteristics of a target or background simultaneously at two or more wavelengths; aerosol monitors, which can monitor and characterize aerosols deposited in the atmosphere by aircraft and missile engines; high-spectral-resolution infrared sensors having spectral resolution of 0.1cm-1 to 0.01cm-1 for middle atmosphere temperature profiling; very sensitive visible/near infrared spectrometers, covering the spectral range from 400 nm to 900 nm, to be used, for example, to obtain spectral data of rocket plumes, to measure atmospheric pollution at levels as low as part-per-trillion, and to observe emissions from the upper atmosphere during heating by ground-based, high-power, high-frequency transmitters.

PHASE I: An analysis shall be conducted which compares the candidate design to current technology in terms of sensitivity, spectral and/or spatial resolution, temporal resolution, size, weight, power consumption, etc. The effort should also include an investigation of how the new technology could be applied to other military and commercial applications.

PHASE II: Develop an working prototype and demonstrate operation in a laboratory environment. Tests shall be conducted to determine how effectively the design meets the requirements of the intended application.

POTENTIAL COMMERCIAL MARKET: The sensor developed under this program will also be useful for non-military applications, such as pollution monitoring, environmental change monitoring, process monitoring in manufacturing, and remote

sensing of earth resources.

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AF96-097 TITLE: Tunable UV Dial Lidar

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop a tunable UV DIAL remote sensing lidar that is eye safe, sufficiently portable for airborne applications, and utilizes rugged laser technology.

DESCRIPTION: DIAL lidar systems are generally large multiple laser systems not suitable for airborne applications. The thrust of this topic is to develop a small tunable DIAL lidar system based on one eye safe UV laser source. A lidar system of this type must be portable, rugged, capable of moderate laser energy and sufficient receiver sensitivity. General system characteristics that are desirable include minimum size and weight for maximum portability, stand alone operability with minimum field support, airborne environment capability and eye safe operation to a range of 15 km with a spatial resolution of 100 m. or less. A desirable laser would be a tunable solid state device operating at an eye safe UV wavelength with 50 to 100 mj. per pulse, a 10 to 15 nsec. pulse length, 10 to 100 Hz repetition rate, and less than 5 mrad. divergence. The receiver can utilize a relatively large telescope to help attain the necessary sensitivity. This lidar will be used to locate, track and identify biological, chemical and other environmentally hazardous aerosol clouds. The measurement capability can focus on tunable differential absorption, polarization properties, fluorescence effects, RAMAN wavelength shifts, multiple wavelength signature, or any other property of the aerosol. This system should be designed to incorporate as many of these attributes as possible.

PHASE I: Review the available technology and develop a design concept for a lidar to investigate hazardous clouds. Computer simulations should support the validity of the concept and establish system parameters.

PHASE II: Develop, fabricate and test system prior to delivery of the lidar to the Air Force.

POTENTIAL COMMERCIAL MARKET: A small, inexpensive, eye safe, aerosol cloud study lidar system would be very marketable as an environmental monitor. The lidar is capable of finding, monitoring, tracking and to some degree identifying aerosol clouds. Chemical and industrial pollution are increasingly important concerns. The lidar would also be a valuable asset to national weather services for the study and verification of plume and cloud formation and dissipation models.

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2. Beland and Krause-Polstorff, "Lidar Measurement of Optical Turbulence: Theory of the Crossed Path Technique", PL-TR-91-2139.
3. McNicholl, "Design and Operation of the GL/OPA Mobile Doppler Lidar", PL-TR-91-2057.

AF96-098 TITLE: Portable Remote Wind Sensing Lidar

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop a wind sensing lidar that is eye safe, sufficiently portable for airborne applications, and takes advantage of low coherence technology.

DESCRIPTION: Presently, portable, eye safe, wind sensing lidars are typically low energy (<25 mj. per pulse), solid state systems operating near 2 microns which employ coherent technology. This technology dictates a complex lidar transmitter; usually a diode pumped primary laser controlled by a seed laser. The transmitter and receiver share a telescope whose size is

somewhat constrained by the diffraction limited optics. The receiver also requires a local oscillator for comparison with the lidar return. Lidars of this type represent an elegant method to measure the frequency Doppler shift induced by wind fields. Currently however, they are expensive, extremely delicate, environmentally sensitive, laboratory devices having insufficient transmitted energy or receiver sensitivity to measure winds at useful distances; eg. 10 km. They also require extensive hardening and packaging for field applications. The thrust of this topic is to develop a wind sensing lidar that utilizes low coherence technology. A small lidar system of this type will be much more robust, capable of greater laser energy and increased receiver sensitivity. General system characteristics that are desirable include minimum size and weight or maximum portability, stand alone operability with minimum field support, airborne environment capability and eye safe operation to a range of 15 km with a solid state device operating to a range of 15 km with a spatial resolution of 100m. or less. A desirable laser would be a solid state device operating at an eye safe wavelength with 50 to 100 mj. per pulse, 10 to 15 nsec. pulse length, 10 to 100 Hz repetition rate, and less than 5 mrad. divergence. The receiver can utilize a relatively large telescope to attain the necessary sensitivity. One possible receiver configuration might include an optical delay line so that returns from successive range bins can be mixed to detect the Doppler shift between bins. This is simply one possible measurement concept.

PHASE I: Develop a concept to measure winds. Computer simulations should support the validity of the concept and establish system parameters.

PHASE II: Develop, fabricate and test prior to delivery of the system to the Air Force.

POTENTIAL COMMERCIAL MARKET: A small, inexpensive, eye safe, wind sensing lidar would be very competitive with alternative technologies for use by national weather services. It would also be a valuable asset at commercial airports as a wind sheer warning device. A related application involves use on marine vessels as a safety assist for helicopter operations.

REFERENCES:
1. Shepherd et al, "The Design, Development and Test of Balloonborne and Groundbased Lidar Systems", PL-TR-91-2191.
2. Beland and Krause-Polstorff, "Lidar Measurement of Optical Turbulence: Theory of the Crossed Path Technique", PL-TR-91-2139.
3. Mc Nicholl, "Design and Operation of the GL/OPA Mobile Doppler Lidar", PL-TR-91-2057.

AF96-099 TITLE: Integrated Tools for Optimum Display of Weather Satellite Image Data

CATEGORY: Basic Research
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop software to automatically generate optimum multichannel displays from weather satellite data at any time or location.

DESCRIPTION: Workstations are available that can handle and display image data from weather satellites. The workstations generally have tools to enhance the contrast between clouds and clear scenes and to display the data in color. Although the tools work well with individual enhancements, there is considerable room for improvement in multichannel displays. All of the weather satellites have at least one solar channel sensing reflected sunlight and a thermal channel sensing upwelling infrared radiation. DoD satellites have thermal channels sensing microwaves as well. The best enhancement for any particular channel varies greatly with global location and time of the scene, as well as the content of the scene. Moreover, the solar, infrared and microwave channels for the same scene need different enhancements. False-color is a powerful tool for display of two or three channels; however, finding the best enhancements for the channels can slow the experienced user and discourage the novice. Software that would predict and apply optimum enhancements for all times, scenes and spectral channels would have great value for all users. Knowing the optimum enhancements can facilitate data compression, data transmission and include more workstations.

PHASE I: Design the software tools and supporting databases for automatic and general enhancements supporting false color.

PHASE II: Develop the tools and databases and demonstrate their utility using microwave, infrared and solar channels in varied scenes from DoD and NOAA polar-orbit weather satellites and the GOES-NEXT geostationary weather satellite.

POTENTIAL COMMERCIAL MARKET: In addition to weather for combat and global DoD applications, users include NOAA, NASA, the climate research community, private-sector forecasters, television stations and users of internet.

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AF96-100 TITLE: Real Time Gaseous/Aqueous Hydrogen Chloride Monitor/Data Logger

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Quality/Civil Engineering

OBJECTIVE: Innovative development of an inexpensive, short response time, light weight, small, gaseous/aqueous, data logging hydrogen chloride monitor.

DESCRIPTION: Federal and local environmental regulations require measurement of ground level concentrations of hydrogen chloride (HCl) emitted from solid rocket plumes. These emissions occur at launch of solid rocket propelled vehicles and during solid rocket motor (SRM) test processes. Monitor accuracy is of high priority. If the hydrogen chloride monitors used are proved to be inaccurate, the result is costly mission delay. Inaccurate HCl measurement could also lead to overexposure of the public and possible litigation against the responsible launching or manufacturing (DoD or commercial) organization. Good plume characterization requires multiple and widely distributed sampling points. This situation dictates an inexpensive, highly accurate, short response time, easily maintained, calibrated, portable instrument. No current HCl monitor fits these requirements nor are any development efforts known to exist that will lead to such an instrument. Typical current instruments have poor response time and do not measure total (gaseous/aqueous) HCl or do measure total HCl but are heavy, expensive, and hard to maintain, calibrate, and use. An innovative approach is required to design/develop a suitable total HCl measuring instrument. The required instrument must have, among other attributes, a response time of less than 5 seconds, weigh less than 10 pounds, be one cubic foot or less in volume, require less than 10 minutes for maintenance and calibration per monitoring event, have on-line data logging capability for all input information, measure gaseous and aqueous HCl in the range of at least 0-100 ppm with a resolution of at least 0.1 ppm, and cost less than $1000.00.

PHASE I: Effort will involve an in depth survey of HCl measuring instrument technology and will result in the design/development/ feasibility demonstration of a conceptual instrument.

PHASE II: Effort will optimize the selected instrument design, produce a prototype production instrument, and provide a demonstration of the prototype instrument to Air Force requirements.

POTENTIAL COMMERCIAL MARKET: A production HCl monitoring instrument, meeting the above specifications, will have wide application and demand among DoD, NASA, and commercial launch facilities, DoD and NASA test facilities, commercial solid rocket motor manufacturers, and DoD and commercial facilities concerned with HCl emissions and incineration.

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AF96-101 TITLE: Technology Transfer/Dual Use - Medical or Industrial Applications of LI Imaging Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Biomedical

OBJECTIVE: Transfer of Laser and Imaging Directorate technology to the medical or industrial community.

DESCRIPTION: The Lasers and Imaging Directorate of the Phillips Laboratory develops imaging systems for military applications. These technologies that are suitable for medical applications or industrial inspection techniques during fabrication

or assembly procedures. Recent advances in laser and optical materials have led to the development of new types of imaging systems with substantially improved performance. These advancements include development of novel compensated imaging, and hyperspectral sensing techniques which provide dramatically improved image quality that may be useful for medical diagnoses or for material inspection. Phase I, II, or III proposals which involve or are expected to involve animal or human testing must be submitted to the Phillips Laboratory along with protocols prepared in accordance with the prescribed DoD format and, if available, pertinent certifications.

PHASE I: An in-depth assessment of potential commercial medical or industrial applications of a selected imaging technology will be required. As a result of this assessment, the initial necessary medical or industrial product concept refinements will be determined and a design will be developed. The proposed Phase I effort shall not involve any animal or human testing. However, if Phase II plans will involve or lead to animal or human testing, the Phillips Laboratory will require delivery of the "protocols" within 3 months after Phase I contract award.

PHASE II: Build or fabricate, test and validate a laboratory demonstration model or prototype based on the commercial applications assessment and the design refinements. Phase II contracts involving any animal or human testing will require additional data deliverables (such as the "Annual Report to the Surgeon General") documenting all animal or human testing. POTENTIAL COMMERCIAL MARKET: The Phillips Laboratory is committed to finding commercial applications for its military developed technologies. The Lasers and Imaging Directorate (LI) considers the area of medical or industrial applications of imaging technologies to be an ideal dual use area for commercialization of LI technology. LI requires partners in the private sector medical or industrial products community to obtain this goal.

POTENTIAL COMMERCIAL MARKET: The Phillips Laboratory is committed to finding commercial applications for its military developed technologies. The Lasers and Imaging Directorate (LI) considers the area of medical or industrial applications of imaging technologies to be an ideal dual use area for commercialization of LI technology. LI requires partners in the private sector medical or industrial products community to obtain this goal.

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8. "The Use of Animals in DoD Programs", DoD Directive 3216.1, Apr 17, 1995.
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12. "DoD Appropriations Act for Fiscal Year 1991", Public Law 101-511, Section 8019, Title 10, United States Code, Section 2241.
13. "Protection of Human Subjects", 32 CFR 219, Jun 18, 1991.
14. "Clinical Investigation and Human Use in Medical Research", AF Policy Directive 40-4, May 11, 1994.
15. "Using Human Subjects in Research Development, Test, and Evaluation", AF Instruction 40-402, Jul 19, 1994.
16. "Clinical Investigations in Medical Research Guidance and Procedures", AF Instruction 40-403, May 19, 1994.

AF96-102 TITLE: Technology Transfer/Dual Use - Medical or Industrial Applications of Laser Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Biomedical

OBJECTIVE: Develop medical diagnostic and surgical products or industrial laser systems using PL/LI solid-state laser technologies.

DESCRIPTION: The Lasers and Imaging Directorate of the Phillips Laboratory (PL/LI) develops high power diode-pumped

solid-state lasers, diode lasers, and diode laser arrays for military applications. These technologies are suitable for medical or industrial applications. Recent advances in Lasers and Laser Materials have led to the development of new types of laser systems with substantially improved performance. These advancements include development of more powerful lasers at wavelengths useful for non-invasive surgical or diagnostics in medicine and novel material inspection or product assembly techniques which provide non-invasive diagnoses, material inspections, or rapid precision material processing. Phase I, II, or III proposals which involve or are expected to involve animals or human testing must be submitted to the Phillips Laboratory along with protocols prepared in accordance with the prescribed DoD format and, if available, pertinent certifications.

PHASE I: An in-depth assessment of a potential commercial medical or industrial applications of a specific selected laser technology will be required. As a result of this assessment, the initial necessary product concept refinements will be determined and and a concept design developed. The proposed Phase I effort shall not involve any animal or human testing. However, if Phase II plans will involve or lead to animal or human testing, the Phillips Laboratory will require delivery of the "protocols" within 3 months after Phase I contract award.

PHASE II: Build or fabricate, test and validate a laboratory demonstration model or prototype based on the Phase I commercial applications assessment and concept design refinements. Phase II contracts involving any animal or human testing will require additional data deliverables (such as the "Annual Report to the Surgeon General") documenting all animals or human testing.

POTENTIAL COMMERCIAL MARKET: The PL is committed to finding commercial applications for its military developed technologies. The Lasers and Imaging Directorate considers the areas of medical or industrial applications of laser technology to be an ideal dual-use area for the commercialization of LI technology.

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17. "Protection of Human Subjects", 32 CFR 219, Jun 18, 1991.
18. "Clinical Investigation and Human Use in Medical Research", AF Policy Directive 40-4, May 11, 1994.
19. "Using Human Subjects in Research Development, Test, and Evaluation", AF Instruction 40-402, Jul 19, 1994.
20. "Clinical Investigations in Medical Research Guidance and Procedures", AF Instruction 40-403, May 19, 1994.

AF96-103 TITLE: Micro Mechanical Adaptive Optics System

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronic Warfare/Directed Energy Weapon

OBJECTIVE: Develop, design and demonstrate that a micro-machining system can be used in building very small adaptive optics systems.

DESCRIPTION: Design and produce a micro miniature adaptive optics system that can be used with a camera or other very low intensity sensor to correct imagery of a source in the far field. This type of an instrument could be very useful to a program such as the Airborne Laser that will be imaging distant targets. The system is desired to be small enough that it could be mounted with a typical set of force optics on a sensor mounted to a telescope. The contractor shall assume that some type of beacon is available in the far field, such as a glint or a star, that can be used as a source for the adaptive optics correction. The intent of this effort is to demonstrate micro-machining can produce a deformable mirror and a miniature wavefront sensor that could be joined with a micro-processor and significantly enhance sensor performance. The foremost challenge in this effort will be to build the miniature deformable mirror, as conceptualized it will be a silicon wafer with a deformable membrane above an array of micro-actuators. Although some components have been conceptualized for a system like this, no detailed design has been attempted.

PHASE I: Design the basic micro systems and demonstrate that such a miniature system is within the state-of-the-art. Prove the feasibility of producing the small package and show how this package can be used with an imaging sensor to significantly improve the optical quality of the image. Design reviews will cover the deformable mirror, the wavefront sensor, the system processing, the adaptive optics system design, and the design for using this adaptive optics system in conjunction with an imaging sensor.

PHASE II: The objectives include building, assembling, and demonstrating the components of the adaptive optics control loop, which shall be demonstrated as a complete system. Extensive testing or detailed characterization of the loop performance is not expected.

POTENTIAL COMMERCIAL MARKET: A competitively costed ultra-small system as conceptualized in this SBIR topic would have several commercial and military customers. Imaging of distant targets that might include solar glints, such as satellites, rockets or airplanes, would have possibilities for significantly improving the optical quality. The system would have to used on telescopes larger than the coherence length of the atmosphere. This would be systems larger than 6 cm diameter at sea level and systems larger than 30 cm at 45,000 ft. altitude. This systems has great potential for astronomical observations. Assuming that the sales price is kept low enough, the product would have a huge market with university and amateur astronomers. An amateur would have the capability for atmospheric corrections and the ability to obtain star images approaching the quality of current space telescopes such as Hubble.

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AF96-104 TITLE: Development of High Power 1.5 to 1.8 Microns Semiconductor Lasers

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronic Warfare/Directed Energy Weapon

OBJECTIVE: Develop high power laser diodes at eye-safe wavelengths with output power greater than or equal to 500 mWatt.

DESCRIPTION: Semiconductor lasers at eye-safe wavelengths, 1.5 to 1.8 microns, are a promising technology with the potential to meet DOD requirements. There are many systems, like the U.S. Army MELIOS, that can cause severe eye damage to the operators. In the area of telecommunication, low power semiconductor lasers can produce several mWatts at the eye-safe wavelengths, but their output power does not meet DOD requirements. This project includes modelling, design, fabrication, test and delivery of semiconductor lasers operating in the 1.5 to 1.8 micron range.

PHASE I: Model and develop an innovative semiconductor laser design capable of achieving the desired output power operating at eye-safe wavelengths.

PHASE II: Optimize the Phase I design to achieve the highest possible output power and longer lifetime while reducing the current threshold. This project shall result in the delivery of several semiconductor lasers.

POTENTIAL COMMERCIAL MARKET: This type of semiconductor laser technology will have a direct effect on the types of systems and hardware that involve direct or indirect contact between personnel and the laser beam. This technology offers strong potential applications in wind shear sensing systems, home security systems, personnel illumination, and law enforcement.

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AF96-105 TITLE: Compact Coupling of High-Power Semiconductor Lasers into Single-Mode Fibers

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronic Warfare/Directed Energy Weapon

OBJECTIVE: Develop a compact system for efficiently coupling high power semiconductor lasers into a single-mode fiber.

DESCRIPTION: Optical fibers offer an optimum way to transfer laser power used in various applications. By coupling a single-mode laser into a single-mode fiber, the brightness of the laser source can be maintained and be more useful for subsequent beam combining and propagation. It is difficult to transfer the energy efficiently from the laser diode to a single-mode fiber due to large non-paraxial angles, mode mismatches, and tight alignment tolerances. The use of micro-optics makes for a very compact, lightweight and robust system which in the future could be transitioned to semiconductor laser arrays. Additional problems at high power levers are: damage at interfaces and feedback off optical surfaces which can disrupt laser operation. Wavelengths of interest are between 0.9 and 1.0 microns.

PHASE I: Design an optical layout and rugged, easily assembled fixturing methodology to couple the energy into a single-mode fiber while minimizing feedback into the laser. A low power, working prototype of a compact system for efficiently coupling semiconductor lasers into a single-mode fiber should be fabricated to demonstrate proof-of-concept. High coupling efficiency (60%) shall be demonstrated through modelling. Deliverables include modelling code (for the design) and the working prototype.

PHASE II: Optimize the design to achieve highest coupling efficiency possible using a 1 Watt or larger semiconductor laser. A working prototype of a compact, fiber-coupled high power semiconductor laser system shall be delivered to the PL.

POTENTIAL COMMERCIAL MARKET: The impact of this technology development would be far reaching, since a compact, lightweight, robust system for coupling semiconductor lasers into single-mode fibers would impact any application requiring

coherent semiconductor lasers. Numerous commercial as well as military applications include countermeasures, LIDAR, medical, environmental sensing and communications.

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AF96-106 TITLE: <u>Continuous Tunable Laser Sources for the 3-5 and 7-14 Micron Regions</u>

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Laser, Optics & Power Systems

OBJECTIVE: Develop efficient compact 3-5 or 7-14 micron continuously tunable laser sources.

DESCRIPTION: The Air Force Phillips Laboratory (PL) is seeking innovative approaches for the development of continuously tunable laser sources for the 3-5 and 7-14 micron spectral regions for a number of applications. In addition to military applications, efficient reliable laser sources between 2-14 um may find many commercial applications such as eye-safe laser radar, remote sensing of atmospheric constituents, and wavelength specific medical applications. For the military applications, an appropriate technology must also meet many performance requirements such as pulse energy, repetition rate, average power, size, weight, and reliability. There is currently no clear choice for a fully satisfactory device technology for these applications. It is anticipated that the eventual solution will most likely involve solid-state lasers pumped with diode laser arrays as the front end of frequency conversion devices. For low average power, all solid-state non-linear optical approaches may be appropriate. For high average power, (hundreds of Watts), gas phase frequency convertors may be required. The Phillips Laboratory is currently conducting a research program using laser pumped molecules as gas phase frequency converters. The proposed technology should emphasize high single pulse energy and low repetition rate, (100-200 Hz). Narrowband output, frequency control and stability should also be considered important elements of the proposed technology.

PHASE I: The goal is to determine if the proposed concept is viable for airborne application, in terms of size, efficiency, and wavelength selectivity. Then, if feasible, a brass board will be built and demonstrated. Another goal is a device capable of 5 Watts average power, continuously tunable over the specified wavelengths.

PHASE II: Develop a detailed design, fabricate and experimentally test the 3-3-5 and/or 7-14 micron tunable laser source.

POTENTIAL COMMERCIAL MARKET: In addition to military applications, compact Mid-Infrared Laser sources may find a great many commercial applications. These include sensing (global wind sensing and low altitude wind shear detection), medical markets that require laser sources that are eye-safe but strongly absorbed in tissues, eye-safe laser radar, and remote sensing of atmospheric constituents.

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AF96-107 TITLE: Semiconductor Lasers Optical Pump Sources to Generate Mid-IR or UV-vis Radiation

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronic Warfare/Directed Energy Weapon

OBJECTIVE: Develop a semiconductor diode laser pumped optical system which will generate either mid-IR or UV-visible radiation.

DESCRIPTION: The mid-infrared (2-15 um) contains many strong fundamental molecular absorption bands [1]. For Example, CO2, CO, NO2, NO, N20, HCI, HF, CH4, H2S and H2O display fundamental absorption bands in the 2.0 to 5.0 micron region. While it is possible to monitor these species spectroscopically, via overtone and combination bands with commercially available semiconductor lasers operating in the near-IR (770nm - 1.6 micron), greatly improved sensitivities can be obtained by pumping a fundamental vibration band in the mid-IR region. The absorption cross sections, for the molecules noted above, are typically 2-8 orders of magnitude larger in this wavelength region than in the near-IR. Clearly, such large increases in the absorption cross sections allows the design parameters of the spectroscopic system to be relaxed, or alternatively, allows for a single high brightness laser source to be multiplexed to several monitoring locations. In a similar vein, accessing wavelengths in the UV-visible allows for laser induced fluorescence (LIF) methods to be used, which, inherently, are high sensitivity methods of detection. Many recent improvements in near-IR semiconductor diode technology [2,3],including beam quality, stability, and power have now made it possible to use these lasers as optical pumps in various nonlinear optical systems to include difference frequency generation [4], second harmonic generation [5], and optical parametric oscillators. Further, the development of improved nonlinear materials [6] parallels the evolution of improved semiconductor pump lasers. Given these technological advances it is desirable to research and develop a compact and relatively rugged diode-pumped nonlinear source to access either the mid-IR or the UV-vis. The generated beam power and quality must be suitable to perform spectroscopic analysis, monitoring or detection of environmental pollutants, process control chemicals, and/or species of importance in atmospheric chemistry or in combustion processes.

PHASE I: Select a diode source for integration into a nonlinear optical system. The system should generate radiative output of sufficient power, in the spectral regions specified above, to accomplish sensitive chemical monitoring. The contractor shall specify what analytical chemical monitoring will benefit from this optical source development. The contractor shall perform preliminary investigations to determine laser, nonlinear crystal and ancillary optics specifications and finally, deliver a preliminary design.

PHASE II: Fabricate and optimize the laser system by conducting tests in the operation in which it will be used. A prototype shall be delivered.

POTENTIAL COMMERCIAL MARKET: These semiconductor lasers will be useful in battlefield situations in which toxic gases may be released. They will also be useful for monitoring ambient air quality in enclosed spaces (home, office, hospitals, vehicles, etc.). Further, direct in-situ monitoring of materials important in military applications, such as lubricants, fuels and other liquids, eg. - water, can indicate purity, degree of degradation, etc. Civilian applications of this technology include toxic gas monitoring (either home, workplace, or industrial site-perimeter monitoring), mine safety monitoring, monitoring of pollutants in stack gasses, on-line monitors of combustion of chemical processes, measurement of atmospheric species, ground water monitoring, and evaluation of common liquids; eg. - engine oil.

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AF96-108 TITLE: High-Power, Coherent InGaAsP Semiconductor Lasers or Amplifiers

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronic Warfare/Directed Energy Weapon

OBJECTIVE: Development of InGaAsP Semiconductor lasers or Amplifiers

DESCRIPTION: InGaAsP/InP semiconductor lasers have been used at low to moderate powers in fiber optic communication systems at 1.3 um and 1.55 um. This effort will use similar technology to develop a 1 Watt, CW coherent 1.55 um semiconductor laser source.

PHASE I: Phase I shall be the design of a coherent, high-power, CW InGaAsP semiconductor laser or amplifier. A low power, coherent, working prototype of an InGaAsP device should be fabricated and coupled into a single-mode optical fiber to demonstrate proof of concept. Power should be measured out of the fiber. The ability to reach higher powers shall be demonstrated through computer modeling. The working prototype shall be delivered to the Government at the close of Phase I.

PHASE II: Phase II shall optimize the design developed in Phase I to achieve a working prototype of a coherent, high-power InGaAsP source coupled through a single-mode optical fiber. Power measured through the fiber should be 1 Watt.

POTENTIAL COMMERCIAL MARKET: (Dual-Use Potential) Numerous commercial and Government applications including countermeasures, LIDAR, medical, laser pumping and communications can use a compact, efficiently fiber-coupled semiconductor laser system operating at these wavelengths. Lasers operating at 1.55 um are currently used in commercial, long-line telephone cable. Increasing the power output of semiconductor lasers operating at this wavelength provides the possible elimination of solid state amplifiers and the possibility of extending the distance between repeaters.

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AF96-109 TITLE: Long Range Imaging and Sensing

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop novel techniques and hardware for use in the UV through LWIR wavelengths to sense and/or image objects.

DESCRIPTION: Recent advances in optical imaging using speckle and interferometric techniques have been developed by the USAF Phillips Laboratory to improve the nations's capability to reconnoiter targets of interest at long ranges and under adverse seeing conditions. These techniques, such as shear beam imaging (SBI), long baseline interferometers, and differential absorption laser radars, may also have application to commercial problems. Examples of these applications include diagnosing manufactured part tolerances from a distance, improved tele-microscopes for bio-medical applications, producing images of malfunctioning satellites on-orbit, or sensing toxic waste products from safe distances. Our goal is to improve on the key components necessary to fulfill military and commercial goals and to transition military derived technology into the private sector. Key components identified for new research, development and improvement include: 1). Detectors needed to sense the

speckles and/or produce the images. Current detector arrays are not adequately sensitive, are relatively slow and are expensive. Moderate density arrays (100 by 100) and fast frame rates of >1 MHz are required. Options to conduct on-chip image processing will also be considered. 2). Specialized illuminator devices which are tailored to the imaging system and detector characteristics and have adequate energy to produce the images. 3). Computer algorithms or procedures for recovering or reconstructing images or enhancing target information. 4). Innovative techniques for sensing or imaging deep space (ranges of 10Mm to 50Mm) objects. 5). Innovative techniques for sensing system and optical aberrations, and similarly innovative techniques for correcting or eliminating aberrations. 6). New method for conducting hyperspectral imaging of objects at a distance. It is not the goal of this topic to develop tracking concepts or improve seeker systems. The winning contractor(s) is expected to propose a demonstration of an imaging technique or component which might solve an imaging problem of interest to the Air Force, or to propose a component or system which will facilitate the imaging process of interest.

PHASE I: Conceptualize, design and assemble a breadboard demonstration of a long range imaging system to a commercial system. Alternatively, the requirement is to build a prototype, sub-scale demonstrator of an improved component or software program which improves the state-of-the-art.

PHASE II: Develop and test an operational system suitable for integration into a commercial or military application and placed into routine use.

POTENTIAL COMMERCIAL MARKET: Long range imaging for commercial applications appears to have very high potential. As microelectronics and bio-medical technologies improve, the requirements for rapid imaging with increased accuracy have begun to stress the capacity of conventional optical sensing and imaging techniques. Ultra-fast imaging sensors have applications ranging from particle physics to industrial process control. Further, the continued expansion of the number of the satellites for commercial and military communications has spawned a need to image orbital objects from the Earth for identification, diagnostic and collision avoidance purposes.

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AF96-110 TITLE: Multi-Function Coatings for the Space Environment

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop thin film coatings for meeting multi-function capabilities and extended lifetime requirements for future sensors operating in the ultraviolet (UV) to very long wavelength infrared (VLWIR) regimes.

DESCRIPTION: Coatings for space based application produced of conventional materials using standard deposition processes often fail to meet spectral and environmental stability requirements. Identification of new coating materials, designs, and coating deposition processes is required to extend the operation of future sensors to the VLWIR regime and to incorporate multiple functions within an individual coating. Generic functions which these coatings may perform include broad-band reflection, anti-reflection, beam splitting, narrow bandpass, and selective rejection. Absorption, reflectance, transmittance, scatter, stress, durability, and stability are among the properties to be addressed. Fabrication cost and yield are also important considerations.

PHASE I: Determine suitable thin film materials and designs for future multispectral surveillance and interceptor sensor applications. Demonstration of a prototype coating of an agreed-upon design. Perform initial characterization of optical, mechanical and thermal properties of resultant coating.

PHASE II: Investigate alternate, advanced processes and techniques for deposition of candidate materials and designs identified during Phase I. Complete characterization of the optical, mechanical and thermal properties of the coating. Evaluation of the producibility (deposition rates, fabrication cost and yield) of the most promising thin film coating.

POTENTIAL COMMERCIAL MARKET: There are many commercial applications which require or would benefit from the use of durable, thin film coatings. Examples include anti-reflection coatings for CRT screens, ophthalmic lenses, architectural glass glazing, and advanced electro-optic devices.

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AF96-111 TITLE: Advanced Clutter Suppression Techniques for Space Based Infrared Sensors

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop and test innovative clutter suppression techniques and algorithms to advance capability beyond current state of the art.

DESCRIPTION: For optimum detection and tracking performance, space based infrared sensor processing requires the removal of background clutter (noise) in an effective and computationally efficient manner. The removal of the unwanted signal due to this clutter requires advanced algorithms based upon spectral, spatial, and temporal techniques. While many such techniques exist, many have not been properly evaluated for optimum utility with regard to specific sensor design. The proposed activity would involve analysis of these unexploited techniques and the development of new techniques that enhance the current performance of Air Force specified, down-looking infrared sensor designs.

PHASE I: Identify the most advanced current clutter suppression techniques and predicted performance against a common infrared earth background scene in the short-wave infrared (2.7um) and medium wave infrared (4.3um) bands. Develop alternative or modified clutter suppression algorithms that improve sensor performance based on analysis.

PHASE II: Develop detailed analysis and simulation demonstrations of clutter suppression algorithms under realistic constraints for current and proposed DoD space-based sensor designs.

POTENTIAL COMMERCIAL MARKET: Basic noise reduction, signal enhancement, and pattern recognition techniques could be used in a variety of sensing commercial applications.

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AF96-112 TITLE: Space or Near Space Flight Experiments Demonstration Support

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Air Vehicle/Space Vehicles

OBJECTIVE: Develop innovative support systems and/or components for space or near space flight experiment demonstration

which offer significant improvements over existing support resources.

DESCRIPTION: The Space Experiments Directorate is responsible for the development of a robust infrastructure to support the insertion of new technology into DoD and U.S. space systems. Requirements to validate new technology through demonstration involve a variety of platforms to accomplish space and near space testing (e.g., high altitude balloons, high altitude aircraft, sounding rockets, free flying satellites, and captive space shuttle payloads). This directorate is interested in innovative developments can, 1) demonstrate significant improvement in ease of operation, 2) reduce operation and acquisition costs, 3) maximize, where possible, usefulness/synergy between the above platforms and payloads, 4) simplify operation and maintenance, 5) provide highly reliable or enhanced data acquisition, 6) code and record (non-volatile storage). Other technologies of interest include: 1) attitude control subsystems, 2) communication subsystems compatible with existing ground station protocols, 3) electrical power subsystems, 4) structural subsystems, 5) thermal control subsystems, 6) ground station systems, 7) integration and test support equipment, and 8) experiment integration development aids (concept to finished product computer-aided development system). Proposals should clearly address the potential platform supported by the proposed product, the modular scalability of the product, the resulting benefits of the system (should address but is not limited to the above significant issues), and the approach to manufacturing and space qualification.

PHASE I: Address the aforementioned systems and areas through superior design with as much ground work in analysis and test as possible. Perform engineering analysis necessary to analytically demonstrate the feasibility of the improved capability. Where there are elements that can not be shown feasible through analysis, risk reduction-testing of those elements will be performed.

PHASE II: Construct and comprehensively test prototype products, on the basis of the Phase I analysis and risk-reduction tests.

POTENTIAL COMMERCIAL MARKET: Technologies addressed by this broad area topic generally apply to making the use of space systems easier and more routine. All of the advancements solicited are geared to making space missions (military and commercial) more inexpensive and reliable, therefore more accessible to a wider range of users, including universities, small businesses, state and local governments. Further, long-term application of these advancements may lead to space vehicle operations that more closely approximate today's operations with aircraft, without the extreme investments that currently prevent most of industry from using space as a resource. Development of these technologies offers application to a range of industries that may not be directly space related. Attitude control, power, structural and thermal control capabilities are broadly applicable to nearly any kind of autonomous vehicle, regardless of its intended purpose.

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AF96-113 TITLE: Innovative Autonomous Station Keeping System for a Large Constellation

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop an innovative autonomous on-board station keeping system which maintains spacecraft distributions of a large constellation.

DESCRIPTION: As part of the continuing effort to reduce the entire system life cycle cost, autonomous station keeping on-board the satellite has been considered as one of the prime candidates, especially since the operation of the Global Positioning System (GPS). Autonomous station keeping capability reduces both the maintenance labor throughout the system's operation cycle and the need for ground tracking capability and communication rates. Through the GPS receiver, accurate satellite position and velocity can be measured easily in some range of altitude. However, selection of the best orbits for constellation, effective methods to correct position error, backup for GPS receivers, scheduling of orbit correction cycles, accuracy, and longevity still need to be developed to obtain a practical autonomous station keeping capability. The challenge for the innovator is to combine the right existing and new components and tools into one system which is suitable for Low Earth Orbit (LEO) and higher altitude constellations with longevity.

PHASE I: The contractor shall produce the conceptual design of one or more autonomous station keeping systems and identify the range of the satellite position drift, frequency of the station keeping delta V operations, maximum duration for the system database update, and the system applicability.

PHASE II: The contractor shall develop a working prototype of the system and its accurate math model to be tested in a laboratory as well as in simulations. The contractor shall also perform system analysis and tests to determine the performance of the system.

POTENTIAL COMMERCIAL MARKET: As the civilian communications needs are increasing and space based communication is spreading over greater areas, more commercial global coverage satellite constellations are being planned. Autonomous station keeping capability is one certain approach for the commercial LEO satellite constellation to stay abreast with competition. Specific commercial applications include the communication satellite constellation and the observation satellite constellation industries.

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AF96-114 TITLE: Information Fusion for Onboard and Offboard Avionics Systems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Technology is sought to allow increased affordable avionics systems effectiveness through onboard and offboard information fusion.

DESCRIPTION: Multisensor information fusion architectures and techniques for use onboard an air vehicle are sought to significantly increase confidence and reliability of target detection and identification, and to increase platform survivability. Geometric based target information from multiple sensors is one of the methods of conducting this fusion. Temporal, machine intelligence, or spectral based information fusion is also possible. Fusion with offboard information is also sought, preferably using similar fusion techniques. Architecture, processor and methods of passing time and space reference information between platforms with sufficient fidelity to allow information fusion are sought as part of this topic. Methods of efficient information fusion using low bandwidth information transmission are especially sought for ease of early implementation using existing onboard and offboard communication mediums.

PHASE I: Concepts will be defined. Specific experiments should be conducted to verify critical aspects of the defined concepts.

PHASE II: Fabricate a breadboard demonstration of the concept defined in Phase I and experimentally demonstrate the concept.

POTENTIAL COMMERCIAL MARKET: Any process requiring correlation of information from disparate sources, each having its own degree of precision and reliability, would benefit from fusion technology. Applications may include scenarios requiring immediate determination of "situation awareness" such as quickly evolving transportation, environmental or natural disasters, medical emergencies, dynamic business operations, and complex manufacturing or chemical processes involving multiple sources of instrumentation and observation for which defect elimination is of critical importance. Matching data bases of finger prints, mug shots, arrest warrants, evidence, and criminal records would potentially remove sources of human error and oversight, offer suggestions for additional data collection, and highlight discovered patterns of criminal activity. Additional applications may be suggested for any process requiring timely results from manual processing and interpretation of multi-source data.

REFERENCES:
1. E. Waltz, J. Llinas, Multisensor Data Fusion, Artech House, Norwood, MA 1990.
2. "Evaluation of Relative Importance Judgement Methods in the Context of Casual Prediction." DTIC Technical Report No. AD-A255718, Aug, 1992.

AF96-115 TITLE: Modular Avionics Development

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Technology is sought to modularize avionics systems and create competition at the avionics module level.

DESCRIPTION: Concepts and technologies to define modular avionics at the lowest reasonable module level are sought. Standard interfaces between avionics modules will also be defined in order to support open architecture concepts. Methods of creating a competitive market at the lowest module level are sought. The use of modularity across the Air Force fleet is the minimum goal. It is preferred that modules be used across the world's DOD and commercial fleets where possible. This has an economic impact. The larger the aircraft fleet market for a given module, the lower the unit price DOD will pay for that module. Methods of allowing affordable introduction of modularity into the existing Air Force, DOD, and other fleets are sought. This will include the use of commercial off the shelf (COTS) components and practices as much as possible. Ability is sought for proposed modules to work initially with existing aircraft wiring, while being upgrade compatible when new wiring is feasible. Modular concepts proposed should include aircraft sensors, avionics processing, and advanced packaging concepts. Offensive and defensive aircraft avionics systems should be considered. Design of particular suggested avionics modules, such as antennas, backplanes, integrated racks, etc., can be considered under this topic.

PHASE I: Define modular concepts, define module levels, define avionics modules, define standard avionics module interfaces, and establish a competitive market concept. Experiments, such as simulations, will be conducted to verify critical aspects of the defined concepts.

PHASE II: Fabricate a breadboard(s) of the concepts defined in Phase I and experimentally demonstrate these concepts. Compatibility with existing aircraft will be demonstrated. Commercial applications of these concepts will also be addressed.

POTENTIAL COMMERCIAL MARKET: COTS components, modules, systems, software, etc. will be addressed in all phases of this effort. Application areas include, but are not limited to, commercial avionics, ground based computer systems, automotive electronics, and commercial space applications, including payloads.

REFERENCES:
Longbrake, R. "Avionics Acquisition, Trends and Future Approaches," AGARD Symposium, Paris, France; Sep 1987.

AF96-116 TITLE: Avionics Sensor Development

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop Sensor Technology for Avionics Systems

DESCRIPTION: Affordable sensor technology is sought for use on air vehicles. This includes active and passive sensors, ultraviolet through low frequency microwave. Sensors are needed for target detection, tracking, recognition, and identification, as well as for vehicle self-defense. Methods of cooperative and noncooperative target identification should be considered. Methods of reducing total sensor suite cost are of strong interest. This includes combining sensor functions, so fewer total sensors are required, as well as methods for reducing the cost of individual sensors. Sensor cost, especially microwave radar cost, is currently a significant cost of an air vehicle. Sensor reliability and supportability should be enhanced as much as possible, with a goal of having sensors that do not need to be repaired during the life of a typical air vehicle, but are so modular that upgrades can occur affordably.

PHASE I: Concepts will be defined. Specific experiments should be conducted to verify critical aspects of the defined concepts.

PHASE II: Fabricate a breadboard demonstration of the concepts defined in Phase I and shall experimentally demonstrate the concept.

POTENTIAL COMMERCIAL MARKET: In addition to "quasi-military" applications, such a law enforcement (detection of drug traffic, etc.) affordable sensor technology may be used to expand the sources and confidence of "situation measurement" for many commercial activities. Examples include: enhancement of commercial aircraft sensor suites for real-time on-board discovery of severe weather conditions and interfering aircraft; surveillance of disaster areas (through clouds and smoke) for response planning and damage estimation; and dispersion of an array of low cost sensors to replace a single, high cost/low reliability sensor to achieve enhanced area surveillance reliability at lower total cost. For example, ground-based fusion of data from the "array" of low cost sensors mounted on those aircraft flying in a traffic sector, might yield a reliable back-up or affordable alternative to air traffic control radars while providing crew members with on-board confidence of a clear flight path.

REFERENCES:
1. Longbrake, R. "Avionics Acquisition, Trends and Future Approaches," AGARD Symposium, Paris, France; Sep 1987.
2. Morris, G., "Airborne Pulsed Doppler Radar," Artech House, Norwood, MA, 1988.
3. Blackman, Samuel, "Multiple Target Tracking with Radar Applications," Artech House, Norwood, MA. 1986.

AF96-117 TITLE: Avionics Simulation Development

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Modeling and Simulation technology is sought that will assist in the development of Avionics systems for air vehicles

DESCRIPTION: The ability is sought to create and use synthetic signatures appropriate for active and passive sensors from ultraviolet sensors through low frequency microwave radar. This signature development capability will support model based automatic target recognition (ATR) since model based ATR requires an ability to predict target signature for the sensors being used. The ability to degrade available signatures based on atmospheric effects is also required, and the ability to model the effects of sensors. The signal developed by the sensor can then be predicted and used in simulations and in air vehicle systems. The ability is also sought to simulate all aspects of the Electronic Warfare engagement. Concepts are sought which will allow networked simulation of all aspects of the air vehicle avionics system.

PHASE I: Concepts will be defined. Specific experiments should be conducted to verify critical aspects of the defined concepts.

PHASE II: Fabricate a breadboard demonstration of the concepts defined in Phase I and shall experimentally demonstrate the concept.

POTENTIAL COMMERCIAL MARKET: The ability to forecast "target" and "background" signatures is needed in robotics, vehicle guidance, remote sensing, search and rescue, landing aids, fire-fighting, mining, geology, crop management, non-destructive testing, environmental protection, energy conservation, building management, HVAC, human and veterinary medicine, and in the design and test of equipment and systems in the fields of electronics, power, propulsion, vehicles, HVAC, structures, and medicine.

REFERENCES:
Andersh, D.J., et al, "High Frequency Electromagnetic Scattering Prediction Code and Environment for Complex Three-Dimensional Objects," IEEE AP Magazine, Feb 94.

AF96-118 TITLE: Common Reference Frame for Multi-Platform Operations

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop a common reference frame for theater-wide reference systems information management and sharing

DESCRIPTION: Current and future military operational concepts emphasize the use of multi-platform operations and the sharing of resources within the theater of operations. This capability would allow many more users access to data from expensive resources and, in some cases, would help extend the operational beneficial life of certain aging airframes. However, before the concepts for sharing such resources are operationally feasible, many technical issues must be resolved. Of particular interest and technical challenge are issues related to the processing and sharing of reference systems information (position, velocity, attitude, and pointing information from, to, and regarding the ownership, other friendlies, enemy operations, and targets). Technical issues that must be addressed include (1) identification of all sources of data including the precision and resolution of that data; (2) identification of all users and their requirements for that data including the specific parameters required and the precision and resolution of the required data; (3) requirements for information about the data, such as time tags, and measures of merit; (4) determination of the appropriate levels of data fusion to be performed by each source and/or user of the data/information; and (5) a consistent and accurate approach to mutual registration of data from multiple sources. The establishment of a common theater reference frame would allow the latter requirement to be fulfilled and would establish an important common perspective from which to address in depth the other technical issues. Potential sources of data include E-3As/AWACS, E-8s/JSTARS, national assets, UAVs, reconnaissance platforms, and combat aircraft. Potential users of the information include combat aircraft, special operations aircraft, transport aircraft, ground based systems and personnel, ships, missiles, and C2 nodes.

PHASE I: Will consist of the development and assessment of concepts for a common reference frame for theater-wide operations. Considerations must include the sources of data and existing reference frame(s) and geographic datums being used by the sources and the data requirements of the users and their existing reference frames and geographic datums. This phase would culminate in the recommendation of a common reference frame for use by all participants in the theater of operations.

PHASE II: The contractor will, through the use of simulation, conduct a demonstration of a common reference frame being used during a representative battlefield scenario. This demonstration system will consist of models of all sources of information, all users of information, and the information content of all data transmissions that would take place during a specific, realistic mission scenario. To identify the information content of the data, it will be necessary to determine the required parameters and the levels of data fusion to be performed by each data source. Other pertinent information includes the required levels of accuracy, resolution, and measures of merit associated with all data to be shared.

POTENTIAL COMMERCIAL MARKET: Dual use applications include environmental and geophysical monitoring which would require mutual registration of data from overhead assets, onboard resources, and fixed ground sites, as well as human services and civil aviation operations that would depend upon information from numerous sources in multiple reference frames.

REFERENCES:
Lewantowicz, Z. and Paschall, R., "Deep Integration of GPS, INS, SAR, and Other Sensor Information," To be published as an invited paper to AGARDograph: "Aerospace Navigation Systems," Section III: "Analysis and Synthesis Methods." For copies, contact WL/AAAI-3, Bldg 635, 2185 Avionics Circle, Wright-Patterson AFB OH 45433-7301. (513) 255-2305

AF96-119 TITLE: <u>Liquid Immersion Cooling for Modular Electronics</u>

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Design, develop, test, and demonstrate a liquid immersion cooling technique for modular electronic systems.

DESCRIPTION: The electronics for modern aircraft and future aircraft are contained on line replaceable modules (LRM) and are housed in integrated avionics racks (IAR). These LRMs contain the electrical, optical, mechanical, and thermal interfaces for a given avionics function. Current LRMs generate less than 200 watts of power, but some contain "hot spots" that require more module cooling. The next generation electronics modules will generate over 200 watts of power. Liquid immersion cooling technologies have been demonstrated in the past in a piece-meal fashion to cool LRMs dissipating up to 700 watts. The US Air Force developed a power supply prototype that was immersion cooled with chlorofluorocarbons (CFC). The US Navy developed a clamshell prototype module that was also immersion cooled. The problem with the existing coolants is that they are heavy, expensive, and environmentally unsafe. In order to install next generation avionics on an aircraft, an innovative liquid immersion cooling technique that employs an environmentally safe and inert coolant must be developed from a systems perspective. This must be a cost efficient and weight conscious technique.

PHASE I: Will involve 1) examining innovative liquid immersion cooling techniques and improved environmentally safe and inert coolants; 2) performing analysis (techniques, cost, manufacturability, environmental impact, aircraft performance

impact, commercial applicability, etc.); 3) establishing a preliminary design; 4) providing a mockup of the innovative technology, and 5) creating a development plan for the chosen cooling concept.

PHASE II: Will involve the detailed design, prototype development, and testing of an appropriate-sized IAR with LRMs that are cooled by this novel concept. This will include any demonstration applicable to a commercial application of this technology concept. The testing will include the rigors of the severe military environments to which the avionics and cooling will be subjected.

POTENTIAL COMMERCIAL MARKET: As commercial avionics become more sophisticated, the packaging of these electronics becomes more dense, hence, the heat load increases. Liquid immersion cooling will help solve this thermal problem. Ground based computers with very high speed processing and massive databanks/memories generate tremendous amounts of heat. A liquid immersion cooling system will help alleviate the heat load for these systems. Other dual-use areas to be considered include automobile electronics/computers which have become very sophisticated and operate in a harsh environment, commercial space applications that use advanced electronic technologies for navigation and guidance systems, and for payloads launched and remaining in space.

REFERENCES:

Immersion Cooled Standard Electronic Clamshell Module, Program Progress Report, September 1992, Contract N00163-91-C-0222.

AF96-120 TITLE: Novel Display Technology for Cockpit Application

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Human Systems Interface

OBJECTIVE: Develop a novel display technology suitable for cockpit applications

DESCRIPTION: It has been shown that a large area display is required for increased pilot Situational Awareness (SA). The Air Force is seeking innovative dual-use (ex: automotive) display technologies scalable to viewing areas of at least 50 square inches with minimal display depth. The display should be capable of full color with a minimum of 80 color groups per inch, video rate, and legible in 10,000 fC of ambient light. Reliability and maintainability will be considered.

PHASE I: Determine the technical merit and feasibility of the ideas submitted and provide a small demonstration of the feasibility of the display.

PHASE II: Optimize the design and provide a prototype demonstration of the display technology meeting the requirements set forth above.

POTENTIAL COMMERCIAL MARKET: Commercial applications include automotive displays, laptop computers, medical instrumentation, electronic games, personal digital assistants, pocket televisions, and high definition television.

REFERENCES:

1. DTIC Report AD# A276415, "Active Matrix Liquid Crystal Display Industry Survey Results," 1993.
2. DTIC Report AD# A282950, "Draft Standard for Color Active Matrix Liquid Crystal Displays in US Military Aircraft," 1993
3. The Society for Information Display International Symposium Digest of Technical Papers, San Jose Conference, June 1994
4. The International Society for Optical Engineering Proceedings for Cockpit Displays, Orlando Conference, April 1994, SPIE 2219
5. "Flat Panel Cockpit Display Requirements and Specification," Advanced Flat Panel Display Technologies, Vol 2174, Paper 9 (Intl Society for Optical Engineering, 1994), SPIE 2174, p. 55-66.
6. "Panoramic Cockpit Displays," Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface, AGARD CP-521, Paper 9, 1992, p. 9-1 to 9-25.

AF96-121 TITLE: Multi-Spectral Fusion Techniques

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop geometry-based multi-spectral fusion identification algorithm techniques

DESCRIPTION: The Air Force uses sensors for air superiority, interdiction, and reconnaissance missions. The most prominent sensors are real beam and synthetic aperture radar (SAR) and forward-looking infrared (FLIR) systems. Although these sensors have been in the inventory for some time, there is no fieldable capability to perform aided or autonomous target recognition (ATR) to augment this large investment. The benefit of new or upgraded sensors has not been quantified. Desert Storm experience suggests that strategic targets will employ extensive camouflage, concealment, and deception to avoid detection. To overcome this difficulty, synergy among the various sensors must be exploited. The Air Force wishes to demonstrate cueing a FLIR sensor with standoff low resolution SAR detections on the F-15E augmented with LANTIRN. Although the observables and characteristics of radio frequency and electro-optic sensors are radically different, there remains one underlying constant: both sensors observe the same target geometry and associated material properties. This project will examine methodologies for fusion of multi-spectral sensor information through reference to a single geometric description of the target object. Elements of this research are (1) resource allocation and directed vision, (2) fusion for ATR, and (3) multi-sensor simulation in Khoros. Resource allocation and directed vision will develop detection prioritization methodologies associated with decision level fusion. Fusion for ATR will develop pixel and feature level fusion techniques and the capability to hypothesize and test across phenomenologies. Multi-Sensor Simulation in Khoros will construct Defense Mapping Agency derived representative backgrounds for registered thermal, laser radar, and SAR data in the Khoros/Cantata computing environment.

PHASE I: Demonstrate decision level fusion of representative SAR, FLIR, and laser radar algorithm output to quantify performance benefits of additional sensor information. Identify target-based features appropriate for feature level fusion. Construct the architecture for developing DMA representative backgrounds.

PHASE II: Develop decision level fusion techniques for selected ATR algorithms. Develop feature level sensor fusion techniques and the capability to hypothesize and test across phenomenologies. Implement the design for developing DMA representative backgrounds that was created in Phase I.

POTENTIAL COMMERCIAL MARKET: Sensor fusion could be used to extend satellite geophysical measurement capability for earth resource estimates and utilization studies, and in both the commercial security and automated manufacturing areas.

REFERENCES:
1. Rosenfeld, Azriel (ed), "Multiresolution Image Processing and Analysis," Springer-Verlag, 1984.
2. Blackman, Samuel, Multiple Target Tracking with Radar Applications, Artech House, Norwood, MA, 1986.

AF96-122 TITLE: Airborne Radar Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop radar software/hardware for improved Cost, Reliability, Installation, Supportability and Performance (CRISP)

DESCRIPTION: US airborne radar systems have given the tactical pilot the superior autonomous capability to control the air and delivery ordinance at will. A number of factors are threatening the fielding of future systems that would continue this tradition. The first is the Cost: the radar system has grown to account for over 10% of the total weapon system production cost, a number that must be reduced. Our future goal is to produce a radar system for no more than 5% of the total weapon system production cost. The second is Risk: recent radar developments have added risk to Engineering & Manufacturing Development (E&MD), our goal is to reduce risk to meet E&MD times. The third is Installation: we must fit within the space and services provided. The future goal is to improve efficiency and reduce packaging size (apertures, radiators, modules, receiver channels, and power supplies). The fourth is Supportability: future radar systems must have much greater meantime between critical failure, higher levels of built-in test, ease of repair and greater use of commercial products. The last is Performance: at least three areas are of concern - deceptive jammers, novel uses of noise jamming and reduced radar cross-section targets, these threats could result in higher cost, development risk and greater installation requirements.

PHASE I: Define an approach and identify potential solutions to improve airborne radar Cost, Risk, Installation, Supportability and Performance (CRISP). Define and identify promising approaches and technologies which can be used to improve CRISP. Identify simulation tools to support this airborne radar investigation.

PHASE II: The Phase I effort will be developed into a radar technology identification and selection methodology. Approaches for addressing specific CRISP concerns will be ranked and only the most promising technology for both military

and nonmilitary users will be developed.

POTENTIAL COMMERCIAL MARKET: The products developed under this effort will include avionics design methodologies, design software and computer simulation tools. These products will be of great benefit for the manufacturers of all electronic equipment by decreasing design time, reducing cost and improving reliability.

REFERENCES:

Longbrake, R. "Avionics Acquisition, Trends and Future Approaches," AGARD Symposium, Paris, France; Sep 1987.

AF96-123 TITLE: Data Extensions for Imaging Sensors

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop methods to degrade quality of sensor data taken under good conditions with high resolution

DESCRIPTION: Data collections measuring sensor performance under a realistic range of real world conditions are difficult and expensive. Measurements made under good environmental conditions and with high resolution could be synthetically degraded to represent a wide range of realistic environmental conditions and sensor capabilities. Such data would be extremely valuable in the development and evaluation of automatic target recognition (ATR) and sensor fusion algorithms.

PHASE I: Identify and evaluate methods for degrading infrared and synthetic aperture radar (SAR) imagery to represent weather effects and reduced sensor resolution.

PHASE II: Develop and implement software to extend measured databases to represent a variety of environmental conditions and sensor capabilities. Evaluate the software and state the limitations on its accuracy and applicability.

POTENTIAL COMMERCIAL MARKET: This evaluation capability could be used in testing of commercial algorithm applications such as security systems and industrial robotics. Development of such systems requires both evaluation of performance bounds under varying conditions and selection of sensors of adequate quality to perform required tasks.

REFERENCES:

Rosenfeld, Azriel (ed), Multiresolution Image Processing and Analysis, Springer-Verlag, 1984.

AF96-124 TITLE: Instrumentation for Digital Radio Frequency Memory (DRFM) Research

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop real-time instrumentation for evaluating the performance and effectiveness of DRFM-based electronic warfare (EW) systems

DESCRIPTION: In order to defeat modern threat weapon systems, designers of advanced coherent electronic countermeasure (ECM) systems would like to use digital RF memories as the core technology of their jammer system. Recent breakthroughs in DRFM technology could provide the capability to substantially improve the self-defense of expensive combat aircraft. However, for the designers involved in the development and application of DRFM technology, a critical need exists for a flexible, low-cost, real-time system that can evaluate the performance capabilities of the DRFM under development. The evaluation system should also be able to evaluate the effectiveness of the ECM techniques generator that is controlling the DRFM. It is highly desirable that developmental DRFM technology be evaluated in the context of a total EW system and with test stimulus that is representative of the actual stimulus found in combat missions. A successful approach to solving this problem needs to address the following: stimulus representative of the threat environment, EW receiver/processor functions, front-end downconversion from RF to baseband, output upconversion from baseband to RF, analysis of output ECM waveform including transmit and receive antenna isolation and interference problems. Additionally, the approach needs to address modularity and flexibility of the final system design.

PHASE I: The contractor will review performance requirements, finalize the design of the evaluation system, and demonstrate key EW processing and analysis functions.

PHASE II: The contractor will fabricate, demonstrate and evaluate the proposed design. Together with the delivery

of the system, the contractor shall provide recommendations for further development and enhancements.

POTENTIAL COMMERCIAL MARKET: This evaluation system could be used as an instrumentation tool for the calibration and acceptance testing of coherent ECM jamming systems. This system can also be used for interface simulation and simulation in large systems such as those found in commercial ship and aircraft control systems. A commercial potential also exists for use of this system during radar and/or communication system design, test and analysis. New products (test equipment) and new evaluation processes developed under this effort will be made available to radar and/or communication systems developers.

REFERENCES:
Stepp, R.K., "Electronic Combat Hardware-in-the-Loop Testing in an Open Air Environment," Master's Thesis, Naval Postgraduate School, AD:A286142 (1994).

AF96-125 TITLE: Tagging Acquisition Mode Radar Signals for Countermeasures

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop technology that will rapidly strip acquisition mode radar signals from microwave bands for input to a jamming subsystem

DESCRIPTION: A weapon system such as a fighter aircraft equipped with a Target Tracking Radar (TTR) and armed with a Semi-Active Radar (SAR) missile must first acquire its target with the TTR operating in the acquisition mode. After approximately locating the target in this mode, the TTR switches to the tracking mode to illuminate the target for the missile which is then launched. If the radar could be successfully jammed before the mode switch, it could be prevented from ever launching its missile. Currently, EW systems are not able to recognize a threat in the acquisition mode quickly enough and transfer pertinent information such as frequency and pulse repetition frequency (PRF) to the jamming subsystem so that the appropriate EW technique can be transmitted in time. It is not feasible or desirable to jam all signals in the band at all times. This effort is intended to develop a nonconventional approach to quickly sorting or tagging only the signals in a radio frequency (RF) spectrum that are associated with radars in the acquisition mode. The jammer can then generate waveforms that are already known to be effective against acquisition radars. The conventional approach of measuring the radar signal parameters and maintaining a track file on each threat is probably too slow for this application since a modern TTR can typically complete the acquisition mode before the identification process is finished. The Air Force is looking for technology that will separate the RF pulses of interest from the rest of the spectrum in as close to real-time as possible with a minimal error rate. The technology of interest here is specifically that of sorting or "filtering" a portion of the microwave spectrum so that only signals from TTRs in the acquisition mode remain for further processing. It is not necessary to consider specific jamming techniques.

PHASE I: Develop technical approach(es) to satisfy the objective and evaluate the probability of success. Identify high risk development that is required and estimate costs.

PHASE II: Design, fabricate and perform feasibility tests of a subsystem that performs desired tagging/sorting.

POTENTIAL COMMERCIAL MARKET: This research into techniques for sorting or "filtering" the microwave spectrum so that only specific types of signals remain, has commercial potential in many area that requires rapid detection of unique signals in a complex environment of other signals. In effect, interfering signals are removed and only the desired ones remain. Commercially, this could be used in satellite communications/television systems to prevent signals from high-power military radars and navigation systems from interfering. Other commercial sensors that could benefit are those that must operate in environments with high levels of interference such as environmental monitors, medical diagnostic instruments, and remote sensors and controllers for manufacturing processes.

REFERENCES:
1. Batuhan Ulug, "An Algorithm for Sinusoidal Interference Reduction using Interactive Maximum Likelihood Estimation Techniques," Master's Thesis, Technical Report 723854-1, April 1993; The Ohio State University ElectroScience Laboratory.
2. P, Stoica, R. Moses, et al., "Maximum Likelihood Estimation of the Parameters of Multiple Simusoids from Noisy Measurements," IEEE Trans Acoustics, Speech, Signal Processing, ASSP-37, no. 3, pp. 378-392, Mar. 1989.
3. M. Braumstein, J. Ralston et al., "Signal Processing approaches to radio frequency interference (RFI) suppression," Proc. SPIE 2230, Algorithms for Synthetic Aperature Radar Imagery, pp. 190-2008 April 1994 Title: Narrowband Interference Removal for Ultra-Wideband Synthetic Aperture Radar.

AF96-126 TITLE: Computer Aided Engineering for Aero-Optics

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop a software package for Computer-Aided-Engineering (CAE) of laser installations aboard aircraft

DESCRIPTION: For a selected aircraft installation site, this package will provide a prediction of laser performance as a function of flight conditions, pointing angle, system dynamics and atmospherics. It is proposed to limit the aero-optic effects to the aircraft-generated turbulence in the region occupied by the engine exhaust gases and the wake vortices. The algorithms and software will be designed to operate conveniently and with reasonable run-time on a high-end PC (486/66 DX Intel chip or Pentium chip) or workstations such as SUN's SPARC 10 series. To this end, the algorithm employed for both laser propagation and Computational Fluid Dynamics (CFD) will be heuristically tailored to the significant regimes identified during the current USAF program on Turbulence Interactions (TI). In addition, the propagation and turbulence data collected during the TI program will be provided as an accessible database for future use. This CAE package would be designed for system engineering applications of interest to the Air Force.

PHASE I: Design and develop a detailed preliminary design specification for the aero-optics CAE.

PHASE II: Code, test and debug the CAE aero-optics software package.

POTENTIAL COMMERCIAL MARKET: (a) Install laser systems (Lidars, navigation sensors, communications, landing aids) on commercial aircraft. (b) More accurately predict flight safety in aircraft landing patterns. (c) Better control of noise pollution at airports.

AF96-127 TITLE: Solid-State Electronics Applied Research

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Explore innovative semiconductor, electro-optic, and electromagnetic materials and device technologies, and demonstrate concept feasibility.

DESCRIPTION: The following subtopics describe areas of the Directorate mission responsibility in electronics.
a. RESEARCH: Explore revolutionary new device concepts and conduct feasibility demonstration efforts on devices with potential for high frequency microwave/millimeter wave, high-speed electronics, and electro-optical applications.
b. MICROELECTRONICS: Examine new device approaches to logic and electronic processing, ultrahigh speed digital switching devices, advanced semiconductor fabrication technology, high-speed/density integrated circuit packaging, power/thermal management techniques, computer based tools for electronic equipment design, and on-chip sensor/functional testability.
c. MICROWAVES: Investigate promising microwave and millimeter wave solid-state and vacuum electronic devices, monolithic integrated circuits, computer-aided design/fabrication, power and low noise amplifiers, signal control components, mixed mode ICs, high density packaging and interconnects, and multichip assemblies.
d. ELECTRO-OPTICS: Develop new and/or improved: 1) lasers and incoherent light sources ranging from deep ultraviolet through infrared (IR) with near IR sources emphasizing 2- to 5-micron tunability; 2) nonlinear devices, materials, and interactions; 3) optical processing (including displays); 4) beam scanners and pointers; 5) modulation and control devices and techniques, including microwave frequencies; 6) detectors and focal plane arrays in the ultraviolet visible, mid-wave IR and long-wave IR bands; 7) micromechanical devices operating in the optical domain; 8) fiber sensors and 2- to 12-micron fiber-optics.

PHASE I: Determine the initial feasibility of the concept through design, physical analysis, mathematical modeling, and measurements.

PHASE II: Develop key processes, validate the model experimentally, explore critical parameters, and optimize the design.

POTENTIAL COMMERCIAL MARKET: Commercial applications that will benefit from innovative electron device technological advancements include high temperature electronics for automotive and jet aircraft engines, optical sensors for

environmental assessment, high speed digital electronics for computers and communication systems, automotive collision avoidance/warning sensors, and miniaturized diagnostics for the medical industry.

REFERENCES:
1. R. Anholt, R. Worley, and R. Neidhard, "Statistical Analysis of GaAs MESFET S-Parameter Equivalent-Circuit Models," International Journal of Microwave and Millimeter Wave Computer-Aided Engineering, Vol. 1, No. 3, 263-270, 1991.
2. C. Wei and J. Hwang, "New Method for Direct Extraction of HBT Equivalent Circuit Parameters," IEEE, International Microwave Symposium, 1994 MTT-S Digest, Vol. 2, pp. 1245-1247.
3. R. Anholt, J. Gerber, R. Tayrani, and J. Pence, "HBT Model Parameter Extractor for SPICE and Harmonic Balance Simulators," IEEE, International Microwave Symposium, 1994 MTT-S Digest, Vol. 2, pp. 1257-1259.
4. P. Ikalainen, S. Fan, and M. Khatibzadeh, "20-W Linear, High Efficiency Internally Matched HBT at 7.5 Ghz," IEEE, International Microwave Symposium, 1994 MTT-S Digest, Vol. 2, pp. 679-682.
5. M.A. Herman and H. Sitter, "Molecular Beam Epitaxy," Spring-Verlag, New York, NY 1989.
6. H. Hasegawa et al., "High Reliability Power GaAs MESFET under RF Overdrive Condition," IEEE MTT-S Digest, 1993, pp 289-292.
7. Y.A. Tkachenko et al., "Gradual Degradation under RF Overdrive of Power GaAS Field-Effect Transistors," GaAs Reliability Workshop Digest, 1993.
8. J.M. Dumas et al., "Long-Term Degradation of GaAs Power MESFETs Induced by Surface Effects," Proc. 1983 Int'l Reliability Physics Symposium, pp 226-227.
9. S. Igi et al., "The Effects of the Passivation Film on the Reliability of High Power GaAs MESFETs," Proc. International Symposium for Testing and Failure Analysis, 1983, pp 302-310.

AF96-128 TITLE: Environmentally Safe-Solvent Cleaning Technique for Wafer Cleaning

CATEGORY: Basic Research
DOD TECHNOLOGIES: Electronics
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop safe-solvent semiconductor wafer cleaning method to replace the hazardous solvent cleaning method.

DESCRIPTION: In fabricating semiconductor wafers, cleanliness of wafer and equipment are critical to obtain a high yield process. The wafer is cleaned many times during its fabrication cycle. The wafer goes through a general cleaning process to remove "dirt" on the wafer, and it goes through a specific cleaning cycle to remove resist and wax. In some cleaning processes, hazardous solvents such as acetone and trichloromethane are still used for degreasing and removing resist and wax from wafers. With restriction on the use of hazardous solvents increasing, an alternative safe-solvent cleaning technique is needed. There are commercially available plasma cleaning systems to clean wafers. This program's purpose is to develop safe-solvent nonplasma cleaning technique that performs comparable to the current cleaning process using the hazardous solvents.

PHASE I: Potential safe-solvent cleaning technique to be identified, characterized and developed.

PHASE II: The cleaning technique would be further developed to the point of being a commercially viable product, which would include full, user-friendly, computer-automation.

POTENTIAL COMMERCIAL MARKET: Semiconductor wafer cleaning is an essential process for every microelectronics manufacturer in the world. Every manufacturer would prefer to and will be required to eliminate hazardous solvents in the near future.

REFERENCES: R. Sherman, J. Grob and W. Whitlock "Dry Surface Cleaning using CO(subscript 2) Snow," J. Vac. Sci. Technol. B9(4),Jul/Aug 1991.

AF96-129 TITLE: Rapid Whole-Wafer Carrier Concentration and Dislocation Density Measurement

CATEGORY: Basic Research
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop production-worthy techniques for mapping carrier concentration and dislocation density in conducting

GaAs:Si wafers.

DESCRIPTION: Lasers, solar cells, and other devices fabricated on conducting doped Gallium Arsenide (GaAs) wafers (GaAs:Si,GaAs:Se, GaAs:Te, etc.) depend critically on high free carrier concentration for good ohmic contacts and low dislocation density to eliminate dark lines and other lossy defects. What is needed is a fast (a few tens of seconds maximum), nondestructive, high-resolution ($\sim$10-micron) apparatus for boule qualification and wafer screening for these quantities before fabrication. In the references, research has shown that infrared optical transmission measurement meets these needs. The next step is to apply infrared video techniques, single-wavelength flood-illuminating the wafer and imaging the transmitted light on a suitable TV camera. Processing the image information, quantifying the data, and storing the data are included.

PHASE I: Demonstrate feasibility of whole-wafer infrared imaging at the necessary wavelengths and of capture and digitization of the image data.

PHASE II: Construct clean-room compatible apparatus for fast-change wafer mounting, and demonstrate data processing and storage techniques.

POTENTIAL COMMERCIAL MARKET: Manufacturers of edge-emitting lasers and of solar cells use doped GaAs as a starting material. A rapid, nondestructive, whole-wafer technique for measuring properties for boule qualification, wafer troubleshooting, and incoming wafer inspection before devices are patterned on the wafer is needed to improve commercial potential. An infrared transmission topography technique for evaluating starting wafers would benefit commercial applications such as optical sensors for environmental assessment, high speed digital electronics for computers and communications systems, and miniaturized diagnostics for the medical industry.

REFERENCES:

1. M.G. Mier, et al., "Infrared Transmission Topography for Whole Wafer- Gallium Arsenide Materials Characterization," Solid-State Electronics 35(3), 319 (1992).
2. D.C. Look, et al., "Nondestructive Mapping of Carrier Concentration and Dislocation Density in n+ Type GaAs," Appl. Phys. Lett. 65(17), 2188 (1994).

AF96-130 TITLE: <u>In Situ Monitor for Advanced III-V Molecular Beam Epitaxy (MBE) Control</u>

CATEGORY: Basic Research
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop in situ sensor-based control to enhance III-V MBE growth process flexibility, reproducibility, and yield.

DESCRIPTION: Molecular beam epitaxy (MBE) is the most advanced crystal growth technique available in terms of the range of structures which can be produced. However, MBE process yield limitations are brought about by the high sensitivity of epitaxial layer properties to growth conditions and the inability to control growth conditions adequately. Present MBE technology relies on the inference of important growth parameters from indirect sensor signals and previous calibration data, together with the often unfulfilled hope that growth conditions will not drift appreciably, both within a given growth run or from run-to-run. Correspondingly, there exists a great need to develop new in situ sensor technologies with the goal of more accurately determining and controlling the actual growth parameters of interest in real-time. Such sensor development would increase process control and would thereby positively impact process reproducibility and yield; it would also positively impact MBE process cost and throughput by reducing the need for costly and time-consuming calibration runs. Development of an in situ sensor-based control scheme is sought which will provide improved control over one or more important MBE growth parameters. Such parameters include but are not limited to average substrate temperature, epitaxial layer surface temperature, incident group III flux, incident group V flux, incident dopant flux (e.g., Si, Be, C), desorbed flux(es), growth rate, lattice mismatch strain, surface composition, and epitaxial layer thickness(es). The relative merit of a given sensor approach may be linked to factors such as 1) nondestructive nature, 2) sensitivity, 3) need for calibration, 4) ease of calibration, 5) ease of implementation on existing MBE chambers, 6) response time, 7) cost, and 8) simplicity of sensor signal interpretation. The likelihood of successful commercialization would benefit significantly from full, user-friendly, computer-automation.

PHASE I: Emphasis will be placed on understanding the sensor capabilities and limitations, and determining the optimal approach for performing real-time feedback control of one or more MBE growth parameters.

PHASE II: The sensor technique will be further developed to the point of being a commercially viable product, including full, user-friendly, computer-automation.

POTENTIAL COMMERCIAL MARKET: MBE growth is used to produce structures for electronic and optoelectronic device applications, thereby providing benefit to commercial applications such as high temperature electronics for automotive and jet aircraft engines, optical sensors for environmental assessment, high speed digital electronics for computers and communications systems, automotive collision avoidance/warning sensors, and miniaturized diagnostics for the medical industry.

REFERENCES:
M.A. Herman and H. Sitter, "Molecular Beam Epitaxy," Spring-Verlag, New York, NY 1989.

AF96-131 TITLE: Electronic Design Automation

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop electronic design automation tools and methods which support complex digital electronic systems design.

DESCRIPTION: The Air Force continuously develops complex electronic components and systems for its weapons. Significant cost savings can be achieved if design times and design errors are reduced and the appropriate factors are considered during the initial design of this equipment. Electronic Design Automation (EDA) or Computer Aided Design (CAD) technologies play a key role in achieving a successful weapon system design while reducing its cost. The AF's primary interests are tools that a) support the retrofitting, upgrading, and reengineering of existing systems, b) dramatically reduce system design and verification time, c) help a design team view and manage complex designs, and d) help a designer work with commercial-off-the- shelf parts. Inputs to a tool should be either an industry standard format such as VHSIC Hardware Description Language (VHDL), libraries of design choices, or some other natural format that is intuitive to the design team member that is targeted to use this tool. Outputs should be compatible with other tools that are used in follow-on stages of the design process. The tool must have interfaces to the CAD or enterprise framework and data bases on which it is intended to operate. Duplication of capabilities that are already commercially available or that are already receiving significant investment by the DOD are strongly discouraged.

PHASE I: The preliminary design of the tool will be performed. The functionality, user interface, and design environment interface will be completely specified.

PHASE II: The tool will be constructed, evaluated, and demonstrated. Reference manuals and user guides will be developed.

POTENTIAL COMMERCIAL MARKET: All tools developed under this topic will be inherently dual-use. This is because the same methods used to design military electronic systems are applicable to commercial systems.

REFERENCES:
ANSI/IEEE 1076 VHSIC Hardware Description Language (VHDL) Reference Manual.

AF96-132 TITLE: Innovative Microelectronics Device Development

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop and demonstrate new device concepts for ultra-high speed, low power, and high density applications.

DESCRIPTION: As we move into the twenty-first century, new demands for high speed, low power, high density circuits are rapidly emerging for commercial and military signal, data, and image processing. To date, Metal Oxide Semiconductor Field Effect Transistor (MOSFET) technology dominates the world of high performance silicon circuits, with Complementary Metal Oxide Semiconductor (CMOS) technology playing an important role in low power, high density applications. To meet the ultra-high speed requirements, many integrated circuits (ICs) require the implementation of heterostructure device technologies such as Si-Ge Heterojunction Bipolar Transistors (HBTs), III-V Complementary Heterostructure Field Effect Transistors (C-HFETs), Heterojunction Bipolar Transistors (HBTs), Metal Semiconductor Field Effect Transistors (MESFETs), and others very high performance devices (HEMTs, RTDs, etc.). The intention of this program is to examine new device approaches, rather than the ones listed above, to allow the realization of ultra-high speed, low power, and high density digital switching applications. Emphasis will be given to those technologies that will yield reproducible high density circuits. Selection of the

demonstration vehicles shall be based on customers future needs and the availability of suppliers transferring these technologies from a research to a production environment.

PHASE I: Device concepts, including material development and fabrication feasibility, shall be demonstrated.

PHASE II: Functional demonstration vehicles and design of potential products shall be completed and the fabrication capability of commercial and military products established.

POTENTIAL COMMERCIAL MARKET: Commercial applications for low power, high density, high frequency IC technology include mobile communication equipment and networks, high density logic/memory components, and consumer electronics.

REFERENCES:

1. A. Cho, "Advances in Material Processing and Device Fabrication," presented at the 2nd International Semiconductor Device Research Symposium (ISDRS '93), pp 7-8 (1993).

2. R. Dutton, and Z. Yu, "New Challenges in Device Design for Integrated Electronic Systems," presented at the 2nd International Semiconductor Device Research Symposium (ISDRS '93), pp 9-14 (1993).

AF96-133 TITLE: Broadband Tunable Lasers for Multiplexing/Demultiplexing Fiber-Optic Sensors

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop integrated diode laser with wideband tuning at high speed and narrow linewidth.

DESCRIPTION: Fiber-optic sensors are being considered for embedded sensors in smart structures. Optical wavelength based sensors have advantages due to their absolute referencing and large multiplexing properties; however, their multiplexing properties have not been fully utilized due to a lack of adequate optical source. Laser sources with wideband tuning at high speeds and narrow linewidth would enable large fiber sensor arrays having high sensitivity and rapid access time. Opto-mechanical approaches, such as the tunable grating external- cavity lasers have demonstrated wide tuning with narrow linewidth, but are bulky, extremely sensitive to mechanical adjustments, and can only be modulated mechanically. Electro-optical approaches offer higher speed, tunability, and compactness, but are limited to a narrow tuning range. The objective of this program is to explore novel approaches to achieve integrated diode laser sources having wideband tunability (>200 nanometers), narrow linewidth (< 1 angstrom), high speed tunability (> 1 nanosecond per nanometer), and having potential for wavelength stability and compact size. Emphasis will be given to designs that impact fiber-optic sensor array access time and resolution. This program shall be divided into two phases addressing device concepts and a functional demonstration of the resulting laser design. It is expected that after Phase II, fabrication capability of commercial and military products will be established.

PHASE I: Device concepts, theoretical modeling, material development and fabrication feasibility shall be demonstrated during Phase I.

PHASE II: Functional demonstration of laser concept, incorporating design and materials achievements from Phase I. A commercially manufacturable laser design shall be completed during Phase II.

POTENTIAL COMMERCIAL MARKET: Commercial applications for broadband tunable laser with narrow linewidth are many. They include coherent communications, high speed data retrieval, industrial process control, laser identification and ranging, and environmental spectroscopic sensing.

REFERENCES:

1. B. Glance, et al. "Fast Frequency-Tunable External-Cavity Laser," Electronics Letters Vol.23, No.3, pp. 98-99, 29 Jan 87

2. Heismann, F. et al. "Narrow-Linewidth, Electro-Optically Tunable InGaAsP-Ti:LiNbO(subscript 3) Extended Cavity Laser," Applied Physics Letters Vol. 51, 164-166, 1987.

3. L. E. Giesler, et al. "Instrumentation Concepts for Multiplexed Bragg Grating Sensors," Sensors and Sensor Integration (1991) SPIE Vol. 1480, pp.138-142.

AF96-134 TITLE: Modeling and Simulation of Monolithic Microwave Integrated Circuits (MMICs) and Interconnects in Microwave Packages

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop modeling and simulation capability for active MMICs and interconnects in high density microwave packages.

DESCRIPTION: As microwave packaging becomes more dense and three-dimensional, it becomes more challenging to handle interconnects between devices and other MMIC chips. There is a need to be able to accurately model and simulate the electromagnetic and thermal effects of the different vertical interconnects that may be used, such as coaxial interconnects, elastomerics, button boards, etc., between substrates to connect MMICs with other MMICs and digital circuits. The simulation must take into account the different substrates that the interconnect will be passing through (i.e. AlN, LTCC, HT., alumina, AlSiC, etc.) as well as if the chip is flipped or right side up. Another problem that the MCM (Multiple Chip Module) designer faces is the ability to simulate an entire active circuit and obtain the S- parameters needed. The electromagnetic simulator program must be able to include zero-dimensional (mathematical, elements without specific geometry) circuit models of the active devices. These circuit models of the active devices would provide a connection between the input and output microstrip matching networks contained within the package. However, the active device models would not interact electromagnetically with the model. The circuit models of the active devices must include dependent sources (i.e. current-controlled current sources, current-controlled voltage sources, voltage- controlled current sources, and voltage-controlled voltage sources). There are two main tasks of this program, interconnects and active MMICs. The offeror is asked to respond to one or both tasks. The findings and results will benefit commercial developers of MCM (Multiple Chip Module) assemblies, high density microwave packages, and Federal agencies involved in developing MCM assemblies.

PHASE I: Research and evaluate 3-D EM simulators to assess software packages for the task effort.

PHASE II: Task 1 - Model and simulate a few different types of interconnects. Perform an evaluation between the different interconnects to determine the most reliable approach (lowest loss, most rugged, etc.). Task 2 - Demonstrate the capability to model and obtain S-parameters of an active circuit in a microwave package and compare the results against measured results.

POTENTIAL COMMERCIAL MARKET: Commercial applications for accurate modeling and simulation of thermal and electromagnetic packaging effects are needed for any application requiring MCMs. The automotive industry could use this for collision avoidance systems and the Smart Highway System.

REFERENCES:
1. R. R. Tamale, "Microelectronics Packaging Handbook," 1989, Van Nostrand Reinhold
2. C. Wei and J. Hwang, "New Method for Direct Extraction of HBT Equivalent Circuit Parameters," IEEE, International Microwave Symposium, 1994 MTT-S Digest, Vol. 2, pp. 1245-1247.
3. R. Anholt, J. Gerber, R. Tayrani, and J. Pence, "HBT Model Parameter Extractor for SPICE and Harmonic Balance Simulators," IEEE, International Microwave Symposium, 1994 MTT-S Digest, Vol. 2, pp. 1257-1259.

AF96-135 TITLE: Advanced Structural Concepts

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop and demonstrate advanced structural concepts for aircraft structures.

DESCRIPTION: The Air Force is seeking new and highly innovative concepts for aircraft structures. Concepts exploiting new designs and structural arrangements, embedded sensors and actuators, new materials, and innovative manufacturing approaches are sought. The new concepts must be affordable, producible and supportable. New concepts are sought for three fundamental categories of aircraft structures: lightweight and low cost structures, smart structures, and extreme environment structures. There is a critical need to simultaneously reduce the weight cost of new aircraft structures. The goal for lightweight, low cost structures is to develop truss and geodesic stiffened composite fuselage and wing structures. Specifically, technologies for truss end fittings and advanced design configurations for geodesic substructure attached to facesheets are sought. Concepts for smart

structures with embedded sensors, actuators, and processors for structural health monitoring and damage detectin, radio frequency antenna performance, and active vibration and structural shape control, including compliant mechanisms, are sought. Concepts area also sought for extreme environment structures for high temperature, high Mach (>Mach 3) vehicles and engine exhaust impinged structures subjected to combined high temperatures and high acoustic loads. Finally, concepts are sought for conducting high temperature testing of these extreme enviroment structures at 700 Btu/sq ft sec in air or inert environment.

PHASE I: The Phase I program must demonstrate the feasibility of the proposed concept sufficient to justify further development and/or scale-up in a Phase II effort. Proof-of-concept subcomponents should be fabricated and tested.

PHASE II: The concepts demonstrated in Phase I will be scaled up and developed in detail. The payoffs and benefits of the technology will be demonstrated by fabrication and testing to meet Air Force requirements.

COMMERCIAL MARKET POTENTIAL: Lightweight and low cost structures will provide technologies for commercial transportation vehicles, sporting goods, and civilian infrastrucure such as composite bridges. Smart structures with embedded sensors and actuators will have application in commercial aviation and ground transportation for crash avoidance, vibration control, and health monitoring and also in structures for robotic equipment. Extreme environment structures technology will have extensive applications for internal combustion engines and turbines and high temperature, stress, or vibration environment industrial equipment, ranging from blast furnaces to nuclear reactors to incinerators.

REFERENCES:

1. Isogrid Design Handbook, NASA CR - 124073
2. "Fabrication and Mechanical Properties of Braided Composite Truss Joints," Hideture Kobayashi and Nobuhito Nakama, Sumitomo Precision Products Co. LTD.
3. 37th International Sampe Symposium, 9-12 March 1992.

AF96-136 TITLE: Advanced Design Methods for Aircraft Structural Technology Integration

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Modeling and Simulation (M&S)

OBJECTIVE: Develop advanced design and multidisciplinary optimization methods for aircraft structures.

DESCRIPTION: The Air Force is seeking new and innovative design and optimization methods to enable the integration of new and highly innovative technologies into aircraft structures. Design and analysis methods significantly influence aircraft structure performance parameters such as weight, cost, signature, service life, producibility, and supportability. New structural design and analysis methods needed to support the development of multidisciplinary design optimization (MDO). The objective is to reduce the design cycle time and to simultaneously optimize performance parameters to meet increasingly stringent design and affordability requirements. Design methods are needed to address the integration of aerodynamics (including recent development in computational fluid dynamics) and flight controls in the context of aircraft structural design optimization. Design and analysis methods are sought for three emerging classes of structural concepts: lightweight, low-cost, low signature structures, smart structures, and extreme environment structures. The impact of conceptual design and preliminary design on the weight, cost, and signature of structures is significant. Low cost concurrent engineering optimization methods are needed to fuse performance requirements with producibility and supportability requirements. New design and analysis methods are needed for smart structures with embedded sensors, actuators, and processors for structural health monitoring and damage detection, radio frequency antenna performance, and active vibration and structural shape control, including optimization of compliant mechanisms. Methods are required to analyze and predict embedded sensor performance, process and interpret sensor data, and predict the effects of embedded sensors on the strength, durability, and damage tolerance of structure. Methods are required to analyze and predict embedded actuator performance and global structural response to embedded actuators. Smart material sensor arrays are required for measuring real-time, steady-state, dynamic strain. Finally, new design and analysis methods are required for extreme environment structures and engine exhaust impinged structures subjected to combined high temperature and acoustic environments. Methods for structural life prediction in these environments are required.

PHASE I: The Phase I program must demonstrate the feasibility of the proposed design and analysis method sufficient to justify further development and/or scale-up in a Phase II effort. The Phase I effort should focus on one of the design and analysis methods described above.

PHASE II: The technology demonstrated in Phase I will be developed in detail. The payoffs and benefits of the technology will be demonstrated by application or testing to meet Air Force objectives.

POTENTIAL COMMERCIAL MARKET: The advanced design and analysis methods being sought have great potential for commercial market use in the civil transportation industry for design of aircraft, automobiles, trucks, buses, and rail cars, and in civil engineering for design of buildings, bridges, and industrial structures.

REFERENCES: Niu, Michael C.Y., "Airframe Structural Design," Conmilit Press, Ltd., 1988.

AF96-137 TITLE: Flight Control Technology and Integration

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Air Vehicle/Space Vehicles

OBJECTIVE: Develop flight control technology to support Air Force Global Reach, Global Power objectives.

DESCRIPTION: The Air Force is interested in the development of one or more of the following advanced flight control and integration technologies for future aircraft: a) innovative control effectors for military aircraft, b) flying qualities research, c) high-fidelity modeling techniques for simulation/flight control analysis involving nonlinear and time varying aerodynamics, d) self-repairing flight control methods including algorithms and/or criteria to help allocate control authority, e) self-repairing control methods to deal with control saturation that might be exacerbated by sudden failure or damage, f) unique hydraulic, pneumatic, and electric technologies capable of reducing the complexity of the flight control actuation system, g) flight management techniques including trajectory optimization concepts to increase pilot/vehicle/mission effectiveness considering both single and multiple air vehicle operations, h) low cost passive terrain estimation sensor, i) structural response feedback techniques for flight control, j) on-board system diagnostics concepts for highly integrated vehicle management systems, k) control system configuration for nonlinear and time varying flight conditions, l) real-time, high-fidelity multisensor image fusion software for piloted vehicle control, m) wavelength multiplex photonic control elements.

PHASE I: Expectations include determining the feasibility, preliminary concept identification, requirements definition, and development of Phase II proposals. Some specific examples are the identification of promising control effector concepts to move into testing, promising control actuation concepts/designs, and assessment and selection of one or two multisensor fusion techniques to move into testing.

PHASE II: Expectations include hardware fabrication, ground testing, simulation or flight testing, and validated, executable software code. Some specific examples include validated designs for one or two high efficiency control effectors, software development and demonstration of image fusion technique.

POTENTIAL COMMERCIAL MARKET: All of the items in this SBIR topic are equally applicable to the civilian and military aircraft sectors. The technology developed will provide for reduced fuel consumption for transport aircraft, reduced design and development costs for flight control systems, more efficient and supportable flight control system architectures, and the ability to operate aircraft safely and effectively in low visibility conditions.

REFERENCES:
1. P.R. Chandler, M.J. Mears, M. Pachter, "A Hybrid LQR/LP Approach for Addressing Actuator Saturation in Feedback Control," IEEE Conference on Decision and Control, Lake Buena Vista, FL, December 1994.
2. P.R. Chandler, M. Pachter, M.J. Mears, "System Identification for Adaptive and Reconfigurable Control,: to appear in the Journal of Guidance, Control, and Dynamics.
3. Mark R. Anderson, "Standard Optimal Pilot Models," AIAA Guidance, Navigation and Control Conference, Scottsdale, AZ, August 1994. Available in almost any engineering technical reference library.
4. Jerry E. Jenkins, "The Nonlinear Initial Response: Vis-a-Vis Roll-Rate Induced Camber Effects,: AIAA Flight Mechanics Conference, Scottsdale, AZ, August 1994.
5. David M. Gleason, "Passive Airborne Detection and Avoidance of Oncoming Terrain Using Gravity Gradiometer."

AF96-138 TITLE: Engineering Research Flight Simulation Technologies

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Modeling and Simulation (M&S)

OBJECTIVE: Develop innovative flight simulation technologies to support development and research of Advanced Aircraft.

DESCRIPTION: The Air Force in interested in innovative new flight simulation technologies that will support systems development or control of Advanced Aircraft. Research in improved network simulation fidelity or latency reduction between multiple simulators on a network, is of particular interest. The Air Force seeks technologies that support a small number of high fidelity entities interacting in virtual research environment. Use of an affordable network architecture is desired. Technologies that optimize aircraft fidelity between local and long haul network entities are needed to support training applications. Novel display technologies, lower life cycle cost simulation techniques, or improved techniques for conducting research using networked simulation are of interest. Application of commercial virtual reality technologies to simplify research simulation is encouraged. Innovative approaches for the use of large High Definition Television (HDTV) Cathode Ray Tubes (CRTs) or flat panel displays in flight simulator instruments and projection systems for visual displays are of interest. Improvements will be considered for any technology, hardware device, or software program/architecture that shows potential for flight simulation advancement.

PHASE I: Phase I shall define the proposed concept, investigate alternatives, and predict performance of the proposed design. Demonstrations of high-risk portions of the design are encouraged, but not required.

PHASE II: Phase II shall fully implement, demonstrate, and test the Phase I design. Results of the test and recommendations for improvements and/or alternatives shall be documented.

POTENTIAL COMMERCIAL MARKET: Improvements in flight simulation technology have application to flight simulators used by the airline industry to satisfy FAA training requirements. Flight simulation technologies can also be applied to the expanding fields of virtual reality, medicine, manufacturing, and entertainment.

REFERENCES:
1. Full Mission Simulation for Research and Development of Air Combat Flight and Attach Management Systems; Goddard & Zeh; AGARD-CP-513; 1991. ADP 006 863
2. Dynamic Latency Measurement Using the Simulator Network Analysis Project (SNAP); Bryant et al. IITSEC; 1994.

AF96-139 TITLE: Aeromechanics Technology for Advanced Flight Vehicles

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Air Vehicle/Space Vehicles

OBJECTIVE: Develop aeromechanics technology to achieve affordable 21st century aircraft with enhanced flight performance and efficient aerodynamic design.

DESCRIPTION: The Air Force is interested in the development of manned and unmanned aircraft with significantly advanced flight characteristics compared to current capabilities. These advanced flight capabilities are realized through innovation in one or a combination of the following aeromechanics technologies: a) rapid, efficient computational fluid dynamics methods for calculating the airflow characteristics over complex aircraft configurations in maneuvering flight, b) accurate engineering design methods for rapid approximation of aerodynamic forces, moments, and viscous effects, c) diagnostic and instrumentation equipment for measurement of surface and flowfield properties in wind tunnel and flight, d) efficient applications of subscale wind tunnel measurements to full scale flight, e) high performance single place and transport aircraft with extended range, extreme maneuverability, and increased payload, f) efficient aircraft/propulsion integration of airbreathing inlet and exhaust nozzles.

PHASE I: Define the proposed concept, outline the basic principles, establish the methods of solution. Present an example of the advanced performance which will result from the technology. Determine the risk and the extent of improvement over existing methods.

PHASE II: Build a prototype application of the equipment or software. Demonstrate the advanced technology under actual engineering conditions.

POTENTIAL COMMERCIAL MARKET: Improved performance and safety of commercial and private aircraft will be realized with application of this technology. Examples are simple effective high lift devices, enhanced short field performance, low cost aircraft design tools for industry, engineering education tools for university, and reduced fuel consumption. Experimental methods, instrumentation, and numerical design methods will be applicable to the design of ground transportation systems with increased fuel economy.

REFERENCES:
1. "Applications of Computational Fluid Dynamics in Aeronautics," AGARD Conference Proceedings No.412, North Atlantic Treaty Organization, Advisory Group for Aerospace Research & Development, Neuilly sur Seine, France. April 1986. ADA 177 380
2. Computational Fluid Mechanics and Heat Transfer, Part 2: "Application of Finite Difference Methods to the Equations of Fluid Mechanics and Heat Transfer," Dale A. Anderson, John C. Tannehill, Richard I. Pletcher; Hemisphere Publishing Corp., Washington DC, 1984.
3. Fundamentals of Aircraft Design, Chapter 4: "Aircraft Operating Envelope," Leland M. Nicolai; METS Inc., San Jose CA, 1984
4. Thrust and Drag: Its Prediction and Verification, Part II: "Wind Tunnel/Flight Correlation of Lift, Drag, and Pitching Moment;" Edited by Eugene E. Covert; American Institute of Aeronautics and Astronautics, New York NY 1985.

AF96-140 TITLE: Development of an Expert System for Computational Fluid Dynamics

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Air Vehicle/Space Vehicles

OBJECTIVE: Establish an expert system to assist the users of computational fluid dynamics (CFD) methods.

DESCRIPTION: Computational fluid dynamics (CFD) is often criticized for the development of codes that only the person who developed the code can use. There is some truth to that statement, and it is not because the code cannot produce accurate results for all users, but because the novice user does not know how to use the tool correctly. While there is seldom only one "right" way to do CFD, there has been a wealth of experience obtained by many users over many years that could provide valuable guidance. Certainly there are some widely accepted "rules" that would be of tremendous help to the novice user, or the user venturing unto unfamiliar territory. This expert guidance applies to all computational aspects of fluid dynamics including 1) the initial definition of the problem, where the type of flow solver and characteristics of the grid are determined, 2) the evaluation of the quality and appropriateness of the resulting grid, and 3) and analysis of the final flow solution. Since CFD is a rapidly developing technology, the structure of such a procedure is very important. It must be easily modified or adjusted as the technology evolves. It must be intuitive and interactive with immediate and clear feedback. It must be transportable to a large number of platforms (workstations) and have the flexibility and "hooks" to accommodate a wide range of CFD codes. Such a procedure would have very widespread application. Universities could use it as an instructive tool. Small companies would benefit from expert advice that would otherwise be too expensive. Major industries would save time and cost, and avoid expensive and/or embarrassing mistakes.

PHASE I: Establish the framework for the expert system. Establish the categories and criteria that will be included. Gather as much of the necessary "expert" information that defines requirements, limitations and rules as possible. Document the above, and describe in detail how the actual system would be implemented.

PHASE II: Develop the expert system. Validate the system for different types of flow solvers and different flow conditions. Distribute the system to selected experts for evaluation and to novice users for feedback on adequacy and "usability." Modify and improve the procedure as needed, then distribute and demonstrate the final product to interested Government organizations.

POTENTIAL COMMERCIAL MARKET: Licensing and supporting CFD related software is a major new industry. Providing user support and training, and producing improvements and modifications that are sure to come as CFD methods and computers continue to evolve, could produce long-term funding. Additional opportunities will exist for the establishment of tailored or special interest versions for specific applications or users.

REFERENCE:
Jambunathan, K., Lai, E., Hartle, S.L., and Burton, B.L., "Development of an Intelligent Front-End for a Computational Fluid Dynamics Package," Artificial Intelligence in Engineering, January 1, 1991, Vol 6, No 1, pp 27-35.

AF96-141 TITLE: Aircraft Wake Turbulence Sensor

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop an aircraft sensor to remotely detect wake turbulence in the vicinity ahead of an aircraft.

DESCRIPTION: Safety is a very important factor in both military and commercial aircraft operations. Aircraft-created turbulence impacts the safety of flight operations in all aspects, from take-off to landing. Military aircraft operations, such as mid-air refueling are greatly affected by aircraft turbulence, specifically wake turbulence. Commercial aircraft operations have been recently affected by the phenomenon. Ground-based sensors have been developed to monitor takeoff and landing glideslopes, and detect wake turbulence and other safety affecting factors. On board aircraft sensors have not yet been developed to provide remote detection of wake turbulence in the vicinity ahead of an aircraft, and therefore provide the crew with enough time to perform any avoidance maneuver. A new sensor system that would provide such capabilities is desired. Ideally, this system would be aircraft mounted and would provide wake turbulence detection by monitoring changes in the electrostatic or electromagnetic charges created by the dynamics of the turbulence in the air, or any other suitable method. It is desirable that this sensor system would have an operating range of a minimum of 15 miles ahead of the sensing aircraft. It is also desired that the system would provide an early warning alarm, to be integrated with the aircraft existing warning systems.

PHASE I: Phase I would identify a new sensor system and its feasibility, or major improvements to existing systems.

PHASE II: Phase II would design, fabricate and test the sensor system. This phase would include integration with existing aircraft sensor systems, in both military and commercial aircraft.

POTENTIAL COMMERCIAL MARKET: Commercial and military aircraft safety would be greatly improved by the development of an onboard wake turbulence sensor. By having a reliable wake turbulence sensor on board, the safe distance between aircrafts could be reduced during takeoff, flight and landing. In airports with great amounts of traffic, this reduction in distance would increase the take-off and landing rates, the movement of cargo and the overall flow of passengers, thus resulting in favorable economic impact.

REFERENCES:
1. Eisenhuth, J.J.; Garodz, L.J.; McCormick, B.W.; Nelson, R.C., "Analysis of experimental measurements of trailing vortex systems of large jet transport aircraft," NAECON '71.
2. Rubin, W.L., "Surveillance Sensor for Monitoring Aerodynamic Conditions Near Aircraft."

AF96-142 TITLE: An Adaptive, Real-Time Situation Assessor for Advanced Cockpits

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Human Systems Interface

OBJECTIVE: Research and develop a robust, real-time Situation Assessor for advanced cockpits

DESCRIPTION: Modern aircraft have access to a multitude of on-board and off-board data sources including sensors, command and control updates, intelligence updates, and premission planning data. In addition, programs are currently in place to improve the ability to provide real-time information in the cockpit to create better situational awareness by providing a common, current "picture of the battlefield." All of these data must be transformed into meaningful information that will accurately represent the situation to the operator via the pilot vehicle interface (PVI). A situation assessor would take as inputs the various aircraft and world state data and synthesize them into a more useable, abstract, higher-level assessment of the flight situation. This assessment would not typically be presented directly to the flight crews because it is more effective to provide assessment outputs to the PVI or to other decision aiding systems for further situational context filtering and processing. This information also must be processed in a timely fashion to support high workload, intensive situations. An innovative approach is sought that takes into account projected future developments in advanced cockpits.

PHASE I: Requirements definition to include an analysis of current and future data sources that could be used as inputs. Design a Situation Assessor based on requirements analysis. Design definition should be sufficient to generate software code in Ada. Design should include an interface control document. Test the design with an existing PVI system.

PHASE II: Implement a prototype Assessor based on the design defined in Phase I and integrate the prototype with a pre-existing PVI system. Demonstrate that the PVI integrated with the Assessor can improve pilot performance.

POTENTIAL COMMERCIAL MARKET: Advanced military and commercial airplane pilots could all benefit from situational assessments that feed existing PVI systems which, in turn, improve situational awareness. Assessment technology is useful for other operators of complex systems including doctors and technicians operating complex medical equipment, engineers operating a process control plant, operators of nuclear power plants, or anywhere else where complex real-time systems are used. For example, the Assessor might feed a system designed to detect and prevent hazardous situations. Additional applications reside in teleoperations for hazardous in-flight or ground-based environments.

REFERENCES:
1. NTIS number: AD-A274 685/7/XAB; Development of the Situation Assessment by Explanation-based Reasoning Tool.
2. NTIS number: AD-A255 751/0/XAB; Machine Perception (La Perception de L'Environment Par Senseurs Automatiques).
3. Endsley (1993). Situation Awareness and Workload: Flip Sides of the Same Coin. Proceedings of the Seventh International Symposium on Aviation Psychology (R.S. Jensen and D. Neumeister, Eds.). Columbus OH: The Ohio State University, pages 906-911.
4. Taylor (1994). Trust and Adaptation Failure: An Experimental Study of Unco-operation Awareness. Proceedings of the 3rd International Workshop on Human-Computer Teamwork. 27-30 September 1994, Cambridge UK.

AF96-143 TITLE: Laser-Specific Vision Protection for Pilots Without Implicating Existing Cockpit Optical Parameters

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Human Systems Interface

OBJECTIVE: Conceive and develop an antilaser technology that will protect aircraft pilots' eyes.

DESCRIPTION: Today's rapidly developing laser technology makes it possible for relatively simple, available, hand-held hardware to be employed as tactical and terrorist weapons against military and civilian cockpits - with pilots' eyes being a prime target. Although some laser protection filter technology has been developed against this potential threat, the implementation of such "protection" necessitates making restrictive compromise and trade-offs in the design of cockpit related hardware. Use of filters, for example, that can scatter, reflect, deflect, or absorb directed laser energy will also adversely affect the pilot's ability to view the outside world, as well as electronic cockpit instruments. External visual scene features are reduced, and colors of the cockpit instruments and external objects are altered. Whether said filtering is applied to cockpit visors, windows, canopies, or pilots' goggles, serious undesirable impact on cockpit operations remains. A reliable solution is being sought that will be based on, and capitalize on, the uniqueness of the laser energy and neutralize its disruptive damaging effects on the pilot's eyes. This, without incurring any of the aforementioned optical penalties associated with the present day filter-protective methods.

PHASE I: Analytically evaluate the feasibility of the proposed concept, develop an approach and provide documentation that describes the proof-of-concept hardware that will be developed during Phase II. A simple breadboard-type demonstration of the concept is also desired in Phase I.

PHASE II: Develop, fabricate, and test the prototype hardware that will be used to demonstrate its compatibility with the implementation and pilot utilization aspects involved in military and commercial aircraft cockpits.

POTENTIAL COMMERCIAL MARKET: Civil aircraft are also at risk from hand-held "laser rifles." Terrorist activities have the potential of acquiring and using these weapons---today! A successful output from this research would therefore also serve the commercial airline and business aircraft industries.

REFERENCES:
1. Sliney, David H. and Myron A. Wolbarsht, Safety with Lasers and Other Optical Sources, Plenum Press, New York, July 1980. Available in Public Libraries.
2. Anderberg, Major General Bengt, and Dr. Myron L. Wolbarsht, Laser Weapons: The Dawn of a New Military Age, Plenum Press, New York, 1992. Available in Public Libraries.
3. Aircrew Laser Eye Protection: Visual Consequences and Mission Performance. (U). ADA 280 557
4. The Effects of Laser Eye Protection Devices (LEPD) on Simulated and Actual F-15E Cockpit Visibility, Thomas, S.R. Ercoline, W.R., et al. (U)
5. Control/Display Concepts for Laser Hardened Cockpits (Interim Program Review by WL/FIGP), February 1995 (U)

AF96-144 TITLE: Fire Suppression and Surveillance

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Quality/Civil Engineering

OBJECTIVE: Explore and exploit new technologies and concepts in the fire protection area.

DESCRIPTION: To date most of the effort in the area of fire protection research has focused on liquid agents that are used to extinguish the fire, meanwhile the areas of detection, discharge, storage and alternative agent types are virtually ignored. There is a great opportunity to achieve some very measurable results in some of these new or unexplored areas. These areas include but are not limited to:
1. Cold Gas Generation -- this is a new and developing technology that promises to have the benefits of near room temperature agent release not available in current gas generation techniques without compromising the weight and volume benefits gained from being a condensed solid,
2. Aircraft Extinguisher System Optimization -- current systems do not utilize any advanced or composite material, have no sophisticated agent discharge system, the varied fluid flow characteristics of Halon replacement chemicals have also been ignored,
3. Passive Infrared (IR) Surveillance -- the technology exist to enable our fire fighters to see through smoke and dust using advanced IR detectors.

PHASE I: Identify area of fire protection to be explored. Investigate possible options and how they relate to field requirements. Begin preliminary design of prototype system.

PHASE II: Construct and test prototype system. Determine realistic system performance and weight reduction benefits. Identify target system for technology transition. Deliver prototype to the Air Force.

POTENTIAL COMMERCIAL MARKET: The technologies when developed would be easily transferred to the civilian fire protection field as well as to other commercial fire protection fields -- aircraft, home, automobile, etc.

REFERENCES:
1. Grosshandler, W., "Evaluation of Alternative In-Flight Fire Suppressants for Full-Scale Testing in Simulated Aircraft Engine Nacelles and Dry Bays," NIST Special Publication 861, NIST PB94-203403, Washington, 1994.
2. R. Reed, V.L. Brady, J.M. Hitner, "Fire Extinguishing Pyrotechnics," Proceedings of the Eighteenth International pyrotechnics Seminar, Breckenridge, Colorado, p. 701, July 1992.

AF96-145 TITLE: Nondestructive Residual Stress Measurements in Aircraft Wheels

CATEGORY: Basic Research
DOD TECHNOLOGIES: Air Vehicle/Space Vehicles

OBJECTIVE: Develop nondestructive techniques for measuring residual stresses in aircraft wheels.

DESCRIPTION: Residual stress greatly improves the fatigue life of structural components by introducing surface compressive residual stresses. These residual stresses are present in shot peened aircraft wheels. Knowledge of the magnitude and thickness distribution of these residual stresses is necessary for accurate life prediction and assessment. Presently, no known nondestructive method exists for such a prediction. Unfortunately, measurement methods that do exist are destructive to the wheel, thus requiring a new wheel to be destroyed in order to quantify the residual stress distributions. Therefore, it is necessary to develop nondestructive techniques for measuring residual stresses in aircraft wheels. The technique should be flexible enough to accurately measure the residual stress distribution throughout the entire geometry of the wheel.

PHASE I: Develop nondestructive residual stress measurement methods.

PHASE II: Construct and deliver a measurement system for nondestructive residual stress measurement.

POTENTIAL COMMERCIAL MARKET: The developed system could be applied not only to military aircraft wheels, but also commercial aircraft wheels and also any other commercial structure that has residual stresses in it.

REFERENCES:
1. Prevey, P.S., "Residual Stress for Designers & metallurgists," American Society for Metals, Metals Park OH 1981, pp.

151-168.
2. Prevey, P.S., "X-Ray Diffraction Residual Stress Techniques," METALS HANDBOOK (R) Ninth Edition, Volume 10, Materials Characterization, pp. 380-393.

AF96-146 TITLE: Target Discrimination for Subsurface Ordnance Characterization

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop algorithms and processes to perform discrimination from a suite of sensors.

DESCRIPTION: The characterization process, determining subsurface Unexploded Ordnance (UXO) locations, currently uses magnetometer and ground penetrating radar data to identify potential targets. However, the majority of the collected data identify anomalies as well as ordnance. It is necessary to discriminate between the true ordnance targets and the erroneous data. The locations for the site characterizations are UXO test ranges scheduled for closure. The algorithms and processes to be developed will be done using raw sensor data provided by the government. In addition to the raw sensor data some historical data is also available.

PHASE I: Formulate algorithm concepts. Develop competing algorithms. Present initial algorithm results. Recommend development of most promising algorithm. Report algorithm. Report algorithm development and test results.

PHASE II: Design target discrimination algorithm system. Acquire system hardware necessary to implement discrimination algorithm. Implement algorithm. Perform test and evaluation of system. Report results.

POTENTIAL COMMERCIAL MARKET: Since the purpose of this technology is to discriminate between subsurface ground clutter and objects of interest, it can be applied to a broad range of commercial and military uses. This technology could be applied to any commercial application requiring the location of subsurface objects, such as: gas lines, power lines, water and sewage lines, and hazardous waste landfill remediation. Companies such as Fleur Daniels, Brown-Root, Bechtel, and Foster Wheeler have a keen interest in applying this technology to standard construction operations. During construction surveys, the location of all subsurface lines is critical to accurately mapping the construction site. These companies recognize that this technology would greatly reduce their operating costs before, during, and following construction. The Utilities Industry also has an interest in this technology. Construction and maintenance of existing lines is currently costly and inaccurate, this technology promises to reduce time and costs, and increase the accuracy of location.

REFERENCE:
R. Kelly, M. Mackenzie, "Sensor Technology Assessment for Ordnance and Explosive Waste Detection and Location." Proceeding of the Unexploded Ordnance Detection and Range-Remediation" Conference, Golden, Colorado, May 1994.

AF96-147 TITLE: Carbon-Carbon for Improved Environmental Quality

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Quality/Civil Engineering
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop low cost carbon-carbon (C-C) composite materials and processes for combustion/incineration applications.

DESCRIPTION: With 85% of the world's energy consumed from the combustion of coal, oil, and natural gas, there is a great need for increased fuel efficiency and complete combustion. Furthermore, C-C composite materials offer an opportunity to increase the efficiency of combustion with significantly higher combustion temperatures, while lowering harmful NOx and SOx emissions through preferentially forming CO2.

PHASE I: Phase I will consist of parametric proof of concept studies using small coupon level articles to demonstrate the viability of the process. Phase I must also clearly define a beneficial usage of C-C materials and pertinent components in applications such as waste recovery; waste incineration; combustion systems, including internal combustion engines; chemical pumps for corrosive chemicals in extreme environments; and pollution control devices. As an example, C-C pistons in internal combustion engines potentially could improve performance through less mass, less friction losses, and tighter seals (low coefficient of thermal expansion); hence, more energy efficient engines while reducing exhaust emissions of NOx. Incineration

applications could benefit from higher combustion temperatures in the presence of carbon. Burners, heaters, and combustors would be potential components. While it makes sense to exploit these applications, it is crucial to develop a method of making the C-C materials at a cost low enough to be viable in these commercial markets. Consequently, concepts are being solicited that have potential for making C-C for between $10 and $50 per pound.

PHASE II: Phase II will develop and characterize the process demonstrated in the Phase I effort. Phase II will also include a market survey of the potential impact of C-C on the sector and a plan to transition/insert the proposed technology.

POTENTIAL COMMERCIAL MARKET: All composite material processes will have direct application in commercial incineration and potentially in automotive engines.

REFERENCES:
Buckley, John D., "Carbon-Carbon, An Overview" Ceramic Bulletin, Vol 67, No. 2, 1988. 2. Taylor, A. H., "Carbon-Carbon Pistons for Internal Combustion Engines" NASA Tech Briefs 9(4), Winter 1985.

AF96-148 TITLE: Electrically or Thermally Conductive Resins for Composite Structures for Space Applications

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Discover new electrically conductive polymeric materials for use in composite structural elements.

DESCRIPTION: Investigate the synthesis, theory, processing and properties of new inherently (i.e. non-metal filled) electrically conductive polymers to provide performance advantage over state-of-the-art materials. While the electrical conductivity of graphite and related fiber reinforcements is currently acceptable, electrically insulating matrix resins limit the utility and performance of composite components, particularly for electrostatic discharge, electromagnetic compatibility, and electrical grounding in spacecraft. Polymer systems with stable electrical conductivity and high thermal stability, and reasonably low processing requirements are of primary interest.

The current state-of-the-art thermal/structural material for use in spacecraft is Aluminum (180 W/mK). Composites offer lighter weight structural options but cannot compete with Aluminum for thermal management because current polymers (matrices and adhesives) are not as thermally conductive. As the trend toward lighter weight spacecraft with higher power density (therefore more waste heat) continues, inherently thermally conductive polymers are required. The goal is to provide isotropic thermal conductivity in polymer matrix composites as a lighter weight replacement for Aluminum.

Areas of emphasis include investigations of (a) theoretical and synthetic chemistry to provide fundamental understanding of molecular requirements for achieving stable conductive properties in organic and semiorganic polymer systems, (b) processing and morphology of polymers to discover approaches for achieving superior conductivity, (c) polymer structure-property correlations to elucidate processing options for achieving desired morphologies and electrical properties, (d) novel composite materials or material configurations to advantageously use multifunctional characteristics of polymers to achieve the desired properties.

PHASE I: The establishment of viable approaches to obtaining improved nonmetallic materials are sought in Phase I efforts.

PHASE II: Follow-on efforts in Phase II will further develop and optimize the materials, processes and correlations made in Phase I. Phase II will also include a market survey of the potential impact of thermally conductive resins for potential users.

POTENTIAL COMMERCIAL MARKET: Electrically conductive matrix resins have potential application in commercial aircraft for grounding and shielding applications. Additionally, the automotive industries have an interest in such materials for similar applications.

REFERENCES:
1. M. A. B. Meador, J. R. Geier, B.S. Good, G. R. Sharp and M. A. Meador, "A Review of Properties and Potential Aerospace Applications of Electrically Conducting Polymers," SAMPE Quarterly, October 1990, pp. 23-31.
2. W. L. Wang, T. H. Wu, "A Study of the Thermal Conductivity of Composite Material Cu-epoxide Resin at Superfluid Helium Temperature."

3. H. L. Wang, T. H. Wu, Physical B. Condensed Matter, 1 Feb 1994, Vol 194, page 475.

AF96-149 TITLE: Switchable Thermal Control Coatings

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop a spacecraft thermal control coating with a switchable solar absorptance to emittance ratio (as/e).

DESCRIPTION: Spacecraft thermal control is ultimately accomplished by the use of spacecraft thermal control coatings. These coatings are optically tailored to reflect the heat from the sun (low solar absorptance, as< =0.20) and allow emittance of excess heat to space (high thermal emittance, e> =0.80). Spacecraft are subject to varying solar loads and equipment operational temperature profiles, resulting in temperature excursions (low temperature extremes when in low power situation and solar eclipse, high temperature extreme when in high power situation and full solar load). To maintain spacecraft components within design margins, existing thermal solutions require fluids (e.g. variable conductance heat pipes), mechanical devices (e.g. louvers), thermal storage (e.g. phase change materials) and/or heaters. To decrease the complexity of spacecraft design and reduce the weight of future Air Force spacecraft, coatings are sought whose solar absorption to emittance ratios can be varied by active or passive methods (by the application of an electric field, thermally by spacecraft temperature and/or by exposure to sunlight and dark).

PHASE I: Develop coating with switchable solar absorptance to emittance ratio (as/e) from 0.20 to 1.0.

PHASE II: Demonstrate the coating system applicability, prelaunch, launch, and space stability, and reproducibility. Produce test samples for industry evaluation. Prepare transition and commercialization plan for the coating system.

POTENTIAL COMMERCIAL MARKET: Material will be available for non-DoD spacecraft applications. Material may have applications in the building, heating and cooling, chemical, and storage industries.

REFERENCES:
1. NTIS Accession Number: N95-14063/8/XAB, "Evaluation of Reformulated Thermal Control Coatings in a Simulated Space Environment. Part 1:YB-71," Cerbus, C.A., Carlin, P.S., Nov 1994.
2. NTIS Accession Number DE93769687/XAB, "Fenestration 2000-Phase II. Review of Advanced Glazing Technology and Study of Benefits for the UK. Final Report," Halcrow Gilbert Associates, LTD., 1992.
3. NTIS Accession Number: DE85000513/XAB, "Solid-State Electrochromic Switchable Window Glazings," Benson, D.K., Tracy, C.E. Ruth, M.R., Aug 1984.
4. NTIS Accession Number DE89005008/XAB, "Vanadium Oxide Thermochromic Materials for Optical Switching Films: Final Technical Report," Jorgenson, G.V., Dec 1988.
5. NTIS Accession Number: DE83001358, "Solar Optical Materials for Innovative Window Designs," Lampert, C.M., Aug 1982.
6. NTIS Accession Number: DE82011193, "Durable Innovative Solar Optical Materials: The International Challenge," Lampert, C.M., Jan 1982.
7. NTIS Accession Number: N72-25924, "Investigation of Phase Change Coatings for Variable Thermal Control of Spacecraft," Kelliher, W. C., Young, P.R., Jun 1972.

AF96-150 TITLE: 3-D Boundary Element Analysis for Composite Joints with Discrete Damage

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Development of 3-D boundary element stress analysis for bolted/bonded composite joints with discrete cracks.

DESCRIPTION: The analyses of composite bolted joints and bonded joints present some of the most important and difficult tasks confronting designers of advanced airframes. In collaboration with a number of prominent airframe manufacturers, the Mechanics and Surface Interactions Branch (WL/MLBM) of the Materials Directorate, USAF Wright Laboratory is engaged in a program to improve the stress analysis of bolted and bonded composite joints. A methodology is being developed in-house using a variational method based on spline approximations of displacements. The boundary element method (BEM) to be

developed for the present SBIR effort shall provide a basis of comparison for the spline method, as well as potentially offering more speed and capability in modeling joints of complex geometries. The required analyses for both Phases shall be limited to linear elastic material responses. The proposal is expected to include graphical representation of the stress solutions from a 2-D BEM analysis of the following problem for a (0 degree/90 degree)s graphite-epoxy laminate (E11=20 Msi, E22=E33=1.5 Msi, G12=G13=0.8 Msi, G23=0.48 Msi, v12=v13=0.3, v23=0.55, a1=-0.4 x 10-6 deg F, a2=a3=15 x 10-6/deg F): the laminate has a width to thickness ratio of 10, is constrained to have zero strains in the 0 degree direction (plane strain), and is exposed to a uniform thermal change of -100 degrees F. Each layer must be modeled discretely. The stresses should be plotted as functions of the ratio (distance from a free edge)/width, showing clearly the extreme and dissipation of boundary layer effects. All non-zero interlaminar stresses should be plotted for a 0/90 deg interface, while nonzero in-plane stresses should be plotted for thickness coordinates lying immediately adjacent to the interface on both sides.

PHASE I: Development expertise in the boundary element method shall be demonstrated by obtaining the interlaminar stress solutions depicted graphically in reference [1] for a (0/90 deg)s graphite-epoxy laminate loaded in tension. Each layer shall be modeled discretely. The contractor shall, in addition, demonstrate the capability of developing 3-D analyses of laminated bodies having anisotropic layers, interacting cracks and arbitrary geometries, according to the Phase II criteria stated below.

PHASE II: A 3-D analysis method meeting all of the criteria stated below shall be developed, and the solutions and computer code shall be delivered to WL/MLBM. Comparisons with the in-house method shall be performed for elastic bolt-loaded, 30-ply composites with multiple, interacting cracks. Solutions to certain additional problems arising from the WL/MLBM in-house research programs addressing bolted joints and bonded joints shall be required. The computer program shall meet the following requirements:

1. The 3-D stresses and strains at arbitrarily specified points and the potential and strain energies of the body are the required outputs.
2. Joints are constructed of laminated composite materials; each lamina shall be discretely modeled, i.e., modeling using effective laminate properties is not permitted.
3. Certain 3-D anisotropic elasticity solutions, specified by WL/MLBM, involving free edges in composite laminates shall be recovered by the model. Comparisons of execution times versus finite elements shall be required for a limited number of these solutions.
4. Bolted joints shall include a countersunk bolt-loaded hole with clamping stresses; elastic deformation of the bolt shall be treated and the contact zones shall be correctly evaluated.
5. Multiple, interacting cracks shall be included as discrete traction-free surfaces.
6. The program shall be readily adaptable to arbitrary geometries and loadings.
7. The program shall be implemented on a deskside-type workstation and have an execution time practical for engineering designers in the field, for laminates comprised of no fewer than 30 plies of arbitrary orientations.

POTENTIAL COMMERCIAL MARKET: The potential exists for a user-friendly, interactive BEM computer code that can accurately predict progressive damage and failure of composite bolted joints of arbitrary geometries, and can aid in load-carrying assessments of bonded joints. As conceived, the end product will be a powerful analysis tool with wide applicability and high demand in the commercial and military aerospace industries, as well as in other industries where composites are utilized, such as automotive, marine and sporting goods.

REFERENCES:

N.J. Pagano, "Stress Fields in Composite Laminates," Int J. Solids Structures, 14, 385-400 (1978).

AF96-151 TITLE: Development of Novel Electro-Optic Materials for Advanced Aircraft Avionics Systems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop and demonstrate high electro-optic, optical and thermal properties in novel polymeric optical systems.

DESCRIPTION: The purpose of this research program is to develop new high performance, electro-optic or second-order NonLinear Optical (NLO) organic/polymeric materials for use in photonic devices. Organic materials have the advantage of exhibiting extremely fast NLO response times compared to their inorganic counterparts; in addition, organic materials can be processed with greater ease and versatility for use in more diverse applications. These materials could potentially be used in a number of Air Force applications including optical computing/guidance systems for aircraft and optical network communication

applications. The development of high performance electro-optic organic materials will provide photonic systems which can operate at several orders of magnitude higher speeds with greater efficiency than current electronic components.

New polymeric materials will be developed through novel synthesis and/or processing techniques. The contractor will demonstrate improved electro-optic properties and incorporate the material(s) into photonic device(s). To perform this task the contractor must exhibit the capability to synthesize/fabricate and process new polymeric materials into fixed highly oriented thin films. The minimum measurement capabilities must include materials structure verification techniques, thermal analysis, optical loss measurement capabilities and electro-optic coefficient determination. Photonic device fabrication capabilities shall also be demonstrated.

The important technical criteria are as follows: the resulting polymer system must be a highly oriented film which retains its orientation following the removal of the poling field or source of orientation. Retention of the second-order NLO electro-optic properties (and thus orientation) should be demonstrated to show the orientation which is induced remains once the source of the orientation is removed. The materials must demonstrate low optical losses. The oriented films must have good thermal stability and high electro-optic properties, which must ultimately be demonstrated in a suitable NLO device. The approach may include (but not be limited to) the synthesis of a novel polymeric system capable of being fabricated into a fixed orientation film, or a material system may be developed in which the organic chromophore is incorporated into a host material with a physical attachment or by blending the components.

PHASE I: In the Phase I SBIR program the contractor is to demonstrate their capability to synthesize, fabricate and/or process thermally stable organic/polymeric materials having electro-optic coefficients of 10-20pm/V, or greater. In Phase I, the thermal stability will be demonstrated as short term retention of 90% of electro-optic coefficient values following exposures of 250 deg C for 20 minutes. These material(s) must exhibit the potential for increased electro-optic properties with further optimization of the materials and/or processing techniques.

PHASE II: In Phase II the contractor will further optimize and screen the series of electro-optic polymer systems developed in Phase I to determine the material(s) which exhibit the highest electro-optic behavior with thermal stability The electro-optic coefficient must be greater than 30pm/V with a goal of 50pm/V. The thermal stability of the material developed in Phase II and later programs will be analyzed with an ultimate goal of retention of the properties with exposures of 350 deg C for 20 minutes. In Phase II long term thermal stability will also be analyzed. The materials must demonstrate low optical losses, which fall in the range of 1dB/cm or less. The synthesis, fabrication and/or processing of those materials will subsequently be improved to produce the optimum stable electro-optic system. Phase II will lead to efforts to translate the new electro-optic polymeric materials into practical electro-optic devices to demonstrate photonic applications such as optical limiting or multi-photon pump lazing.

POTENTIAL COMMERCIAL MARKET: Electro-optic polymeric materials have the potential for defense applications (i.e. "flight-by-light") as well as commercial applications including optical computing, optical communication networks and other high speed, high efficiency photonic applications. This program would have significant impact on the development of commercially available electro-optic modulators and interconnects. That would impact industries dealing with the manufacture of microelectronic systems.

REFERENCES:

B.A. Reinhardt, R. Kannan, and J.C. Bhatt, "The Expanding Role of Aromatic Heterocyclic Rings as Functional Groups in the Design of New Nonlinear Optical Materials," SPIE Proc. Vol. 2229, Nonlinear Optical Materials for Switching and Limiting, ed. by M.J. Soileau, p. 24-32 (1994).

AF96-152 TITLE: Automated Data Acquisition for In-Situ Material-Process Modeling

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop an automated real-time model for process control to accelerate material processing research.

DESCRIPTION: Materials research, more specifically, knowledge regarding the interdependency of material, process, and shape for processing functionally gradient materials is progressing at a rate faster than the processing technology and process researchers and/or operators are capable of observing and in amounts of information far exceeding what a human can digest. This requires that the versatility of the processing equipment be utilized to its complete potential to augment the researcher and/or process operator in adapting to ever changing processing conditions. The first step is to encode current understanding of how each input of the process affects the outputs, which may require one or more linear or non-linear models. Once invoked

the performance of these models are monitored by a control system supervisor model, which is capable of constructing a model from empirical data. This model is then compared with the encoded models to identify differences, and based upon defined material quality matrices, a need or priority is established for model refinement. The empirical data acquisition, storage and representation is crucial to system/operator interaction in directing the process discovery, responding to varying process conditions and subsequently to validate model refinements and new processing knowledge. If the data is skewed in time or value, i.e., if process noise cannot be characterized and distinguished from the true process behavior then model refinements will suffer in terms of degradation and credibility relative to discovery of new processing knowledge. This level of sophistication in data acquisition requires that the data collection system have bi-directional control of the process sensors and actuators.

PHASE I: Demonstration of a data acquisition system connecting all of the sensors and actuators to the computer. Develop preliminary identification tests to determine areas of improvement and capability of characterizing and distinguishing process noise.

PHASE II: Design and implement a process discovery capability for at least two or more processes involving thin film deposition for high temperature, high performance aircraft or spacecraft components such as thermal barrier coatings of turbine blades, interface coatings of fibers for metal or ceramic matrix composites, III-IV semiconductor processing or superconducting films for microwave phased array radar applications.

POTENTIAL COMMERCIAL MARKET: The developed technology would have broad commercial appeal in improving the quality and lowering the costs of processing advanced thin film materials ranging from electro-optical materials for semiconductors, superconductors, thin-film displays, etc. to advanced multi-layer coatings for commercial aircraft and engine systems. All of these commercial applications have analogous opportunities to extend product thermal/fatigue limits with advanced processing but are constrained by affordability considerations similar to those faced by the DoD.

REFERENCES:
1. Stark, E.F., & Laube, S.J.P., "Artificial Intelligence in Process Control of Pulsed Laser Deposition," International Symposium on Artificial Intelligence in Real-Time Control, Valencia, Spain, 5 Oct 1994. ASC-94-0099.
2. Laube, S.J.P., "Hierarchical Control of Pulsed Laser Deposition Processes for Manufacture," Dissertation submitted to the Division of Research and Advanced Studies for the University of Cincinnati, Cincinnati OH, 15 Feb 1994.
3. Garrett, P.H., Heyob, J.J., Hunt, V.J., LeClair, S.R., & Patterson, O.D., "Decoupled Flux Control for Molecular Beam Epitaxy," IEEE Transactions on Semiconductor Manufacturing, Vol. 6, No. 4, November 1993, pp 348-356. ASD Case No. 92-0023.
4. Stark, E.F. & Laube, S.J.P., "Self-Directed Control of Pulsed Laser Deposition Process, Journal of Materials Engineering and Performance, Vol. 2, Issue 5, ASM International, Oct 1993, pp 721-726.
5. Adams, S.J., "Implementation of a Robust Algorithm for Compensation of Shutter Opening Induced Flux Transients for the Molecular Beam Epitaxy Process," Masters Thesis, Department of Computer Science and Engineering, Wright State University, Dayton OH, Jun 1993.
6. Heyob, J.J., "The Process Discovery Autotuner," Master's Thesis, Department of Electrical and Computer Engineering, University of Cincinnati, Cincinnati, OH Jun 1991.

AF96-153 TITLE: Nondestructive Evaluation/Characterization

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Development of new nondestructive inspection/evaluation techniques for aerospace systems.

DESCRIPTION: Advanced innovative approaches are needed for the development of new and improved nondestructive inspection and evaluation (NDI/E) techniques. These approaches should be for detection, imaging, and characterization of flaws and other integrity-reducing surface and bulk anomalies in aerospace vehicle and engine components, including corrosion and crack detection or for in-process, noninvasive sensing of processing conditions. Technical approaches proposed must achieve clearly significant improvements in the standard techniques currently being used in factory and/or Air Force Air Logistics Center inspections. Alternately, approaches must identify new inspection and evaluation technologies which have capabilities far superior to those currently used. These alternate approaches must have the clear potential for ultimate use in realistic manufacturing or in-service environments.

PHASE I: This program will address the initial formulation, fabrication, and evaluation of specific NDI/E techniques for demonstration of proof of concept.

PHASE II: This program will perform enhanced development for optimization of the NDI/E techniques investigated in Phase I.

POTENTIAL COMMERCIAL MARKET: The developed approaches would have broad commercial applicability due to the large number of commercial aircraft and engine systems that have problems of a very similar nature to those faced by the DoD.

AF96-154 TITLE: Metallic Structural Materials for Air Force Systems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop, characterize, and model metallic structural materials

DESCRIPTION: New approaches are requested to: (a) develop and characterize gamma titanium aluminide intermetallic materials (up to 1800 degrees F); (b) characterize, understand, and model damage initiation and growth in metallics used in or proposed for use in turbine engines; and (c) develop continuous filament reinforced Ti-matrix composites with improved mechanical properties. For gamma titanium aluminide intermetallic materials, research is limited to: (a) methods for modeling intermetallics which lend insight into chemistry selection and control, as well as microstructural selection and control; (b) methods of synthesizing intermetallics to provide chemistry and microstructural control on a submicron scale while maintaining the ability to vary and control the final microstructural scale; and (c) methods for environmental protection of intermetallics (both monolithic and composites) aimed at providing long life under cyclic oxidation conditions. For damage initiation and growth in turbine engine metallics, proposals must describe new, innovative experimental test techniques and/or analytical modeling approaches for the characterization of life-limiting mechanical properties such as low-cycle fatigue (LCF), high-cycle fatigue (HCF), thermomechanical fatigue, high frequency fatigue, combined HCF/LCF, fatigue crack growth, and creep/fatigue interactions. Special emphasis is placed on damage tolerance and high temperature, often time-dependent, properties, leading to the development of life prediction models. For continuously reinforced (continuous filament) Ti-matrix composites proposals must describe approaches for producing improve mechanical properties (damage tolerance, creep, and the ability to support multi-axial loads are mechanical properties of specific interest) and should focus on methods or concepts for control of interface properties, control of the spacing of fibers, or control of matrix composition and microstructure.

PHASE I: Develop new approaches or metholologies for manufacturing and processing materials or predicting the useful life of materials in an operational environment.

PHASE II: Will be structured to develop and refine those feasible concepts to the point where an assessment could be made of the ultimate potential to help meet Air Force advanced materials needs.

POTENTIAL COMMERCIAL MARKET: The developed approaches could have broad commercial applicability due to the large number of commercial aircraft and engine systems that have materials requirements of a very similar nature to those faced by the DoD. Various energy conservation applications, e.g., radiant burners, heat exchanger, and power turbines, are also pertinent.

REFERENCES:
1. D.B. Miracle, P.R. Smith, and J.A. Graves; "A Review of the Status and Developmental Issues for Continuously-Reinforced Ti-Aluminide Composites for Structural Applications," in Intermetallic Matrix Composites III, (J.A. Graves, R.R. Bowman, and J.J. Lewandowski, eds.), MRS Proceedings, Vol 350, pp. 133-142, (1994).
2. D.M. Dimiduk, M.G. Mendiratta, and P.R. Subramanian; "Development Approaches for Advanced Intermetallics Materials - Historical Perspective and Selected Successes," in Structural Intermetallics, R. Darolia, J.J. Lewandonski, C.T. Liu, P.L. Martin, D.B. Miracle, M.V. Nathol eds., The Minerals, Metals, and Materials Society (TMS), Warrendale, PA (1993) p. 619-630.

AF96-155 TITLE: High Temperature Structural Materials for Advanced Air Force Systems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop and characterize advanced high temperature structural materials.

DESCRIPTION: New approaches are requested to develop and characterize (a) advanced high temperature structural ceramic composites (1800 degrees F to 3500 degrees F, excluding carbon-carbon composites), (b) intermetallic materials and composites (1800 degrees F to 3000 degrees F, excluding nickel aluminides) and (c) model forming processes for advanced structural materials. For ceramic composites, research is limited to continuous ceramic fiber reinforced ceramic matrix systems and may include the following: (a) new, unique ceramic composite development; (b) fiber/matrix interface treatments engineered for toughened behavior and stability; (c) continuous ceramic fiber development; (d) test techniques to determine mechanical and physical behavior (such as failure modes, crack and void growth, oxidation, stress-strain, cyclic stress-strain, etc.) as a function of temperature and loading history; and (e) analytical modeling of composite behavior. For intermetallic materials, research is limited to (a) methods for modeling intermetallics which lend insight into chemistry selection and control, as well as microstructural selection and control; (b) methods of synthesizing intermetallics to provide chemistry and microstructural control on a submicron scale while maintaining the ability to vary and control the final microstructural scale; and (c) methods for environmental protection of intermetallics (both monolithic and composites) aimed at providing long life under cyclic oxidation conditions. For modeling of forming processes, research may include modeling of (a) the unit forming process, (b) the material behavior in response to the demands of the unit process, (c) the interface between the work piece and the die or mold, and (d) novel methods for obtaining physical property data and constitutive equations for insertion in models.

PHASE I: Develop new approaches or methodologies for manufacturing and processing materials or predicting the useful life of materials in an operational environment.

PHASE II: Will be structured to develop and refine those feasible concepts to the point where an assessment could be made of the ultimate potential to help meet Air Force advanced materials needs.

POTENTIAL COMMERCIAL MARKET: The developed approaches would have broad commercial applicability due to the large number of commercial aircraft and engine systems that have materials requirements of a very similar nature to those faced by the DoD. Various energy conservation applications, e.g., radiant burners, heat exchanger, and power turbines, are also pertinent.

REFERENCES:
1. "Ultrahigh Temperature Assessment Study-Ceramic Matrix Composites," E.L. Courtright, H.C. Graham, A.P. Katz, and R.J. Kerans, WL-TR-91-4061, Materials Directorate, Wright Laboratory, Air Force Materiel Command, Wright-Patterson AFB, OH, Sep 1992. ADA 262 740.
2. D.M. Dimiduk, M.G. Mendiratta, and P.R. Subramanian; "Development Approaches for Advanced Intermetallics Materials-Historical Perspective and Selected Successes," in Structural Intermetallics, R. Darolia, J.J. Lewandonski, C.T. Liu, P.L. Martin, D.B., Miracle, M.V. Natol eds., The Minerals, Metals, and Materials Society (TMS), Warrendale, PA (1993) p. 619-630.

AF96-156 TITLE: Advanced Infrared Optical Materials

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop and characterize new infrared optical materials to protect personnel and sensors from laser hazards.

DESCRIPTION: The expanded use of lasers in many applications, including range finders and target designators, necessitates the protection of assets from accidental exposure. New linear and nonlinear materials are sought for use in protection schemes in infrared spectrum from NIR to LWIR (0.7-14 microns). It is not necessary for a single material to function through the entire spectral range but should operate in one of the principal bands (e.g. NIR, MWIR, LWIR). Examples of some protection schemes in which successful materials could be implemented include tunable reflection filters (MWIR, LWIR), switchable polarizers (MWIR, LWIR), optical power limiters (NIR), visibly transparent NIR absorbing filters, and high-speed electrochromic materials.

PHASE I: During this phase the offeror will demonstrate the feasibility of a material to satisfactorily operate in one of the listed protection schemes. Proposals should demonstrate reasonable expectation that "proof of principle" can be attained within Phase I.

PHASE II: Optimize the critical performance parameters and demonstrate performance of the material in one feasible protection scheme.

POTENTIAL COMMERCIAL MARKET: This technology will have broad commercial applications involving lasers and will

provide needed safety devices for work protection.

REFERENCES:
1. "Broadband Near IR Laser Hazard Filters, Phase I Final Report," G. Savant, Physical Optics Corp, 2 Oct 1990, Report Number XA-USAMRDC.
2. "Broadband Thermal Optical Limiter for the Protection of Eyes and Sensors (Patent Application)," B.L. Justis, Dept of the Navy, 31 May 1994, Report Number PAT-APPL-8-251 146.
3. "Analysis and Evaluation of Technical Data on the Photochromic and Nonlinear Optical Properties of Materials," R.F. Cozzens, George Mason University, 15 Mar 1990.

AF96-157 TITLE: Nonlinear Optical Materials

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop nonlinear optical materials with superior properties as compared to those presently available.

DESCRIPTION: Nonlinear optical (NLO) materials are required for a variety of Air Force applications including electro-optic countermeasures, LIDAR, laser radar, optical signal processing, and optical interconnects. These applications require new laser sources (optical parametric oscillators and harmonic generators) and electro-optic devices (directional couplers, guided-wave interferometers, and spatial light modulators). However, presently available materials are unsatisfactory for many applications due to small nonlinearities, poor optical clarity, long response times, difficulty in processing for devices, and other factors. Proposed efforts shall address inorganic or organic materials in bulk or thin-film forms which exhibit large second-order nonlinear effects. Strongest interest is in bulk crystals for frequency conversion to the 2- to 12-micron wavelength range and in thin films for guided-wave devices in the 0.7- to 1.0-micron range. Innovative techniques for preparing new materials or for improving the growth or processing of known materials are encouraged. Nonlinear optical devices may be examined only as a minor part of a materials effort for the purpose of evaluating and demonstrating the properties of the material(s).

PHASE I: The objective is to demonstrate the proposed growth or processing techniques.

PHASE II: The objective is to develop advanced nonlinear materials and relevant processes to demonstrate potential.

POTENTIAL COMMERCIAL MARKET: Materials technology is fundamental to all applications, military and commercial. Examples of commercial applications for NLO bulk crystals are LIDAR for environmental monitoring, medical lasers, and scientific instruments. Examples for NLO thin films are optical interconnects for electronic chips and packages, switching networks for communications and automatic object recognition systems.

REFERENCES:
1. Bordui, Peter F. and Martin M. Fejer, "Inorganic Crystals for Nonlinear Optical Frequency Conversion," Annual Review of Materials Science (Volume 23), ed. Robert A. Laudise et al Annual Reviews Inc., 1993.
2. Dmitriev, V.G., G.G. Gurzadyan, and D.N. Nikogosyan, Handbook of Nonlinear Optical Crystals, Springer-Verlag, 1991.
3. Baumgartner, R.A. and R.L. Byer, "Optical Parametric Amplification, IEEE Journal of Quantum Electronics," QE-15 (1979), pp. 432-444.
4. Fejer, Martin M. et al, "Quasi-Phase-Matched Second Harmonic Generation: Tuning and Tolerances," IEEE Journal of Quantum Electronics QE-28 (1992), pp. 2631-2654.
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AF96-158 TITLE: Epitaxial Growth of Silicon Carbide (SiC)

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop advanced, innovative epitaxial processes for the growth of silicon carbide for electronic applications.

DESCRIPTION: Advanced Air Force systems will require new and novel semiconducting materials to meet challenging power, frequency, speed, and temperature requirements. Conventional semiconductors such as bulk silicon and gallium arsenide cannot meet these requirements. Silicon carbide has many interesting properties such as wide band gap, high breakdown field and physical strength, which make it attractive for high temperature and high power applications. This task seeks to develop new and innovative approaches for the growth of epitaxial silicon carbide. All polytypes are of interest as well as alloys or heterostructures of silicon carbide with III-V semiconductors. While homoepitaxy of SiC to bulk SiC is of primary interest, growth on new substrates will be considered. The offeror is reminded that this is a materials task and projects that are primarily device development or device processing will be considered nonresponsive.

PHASE I: Phase I will address process development and initial testing to show proof of concept. Modeling studies of growth processes or materials properties are appropriate. A deliverable of a representative test sample to the government is encouraged.

PHASE II: Phase II will develop the advanced semiconducting material or process to demonstrate the potential application. Modeling studies of growth processes or materials properties are appropriate. Deliverables of test materials to the government for testing is encouraged.

POTENTIAL COMMERCIAL MARKET: Microwave devices made from SiC will exhibit high power, high frequency operation (e.g. 20 watt in X-band at room temperature) with higher package density and reduced cooling subsystem requirements. In addition, the high temperature nature of SiC permits the development of a host of harsh environment electronic devices. SiC electronics have many commercial applications. The automotive industry needs reliable materials and devices for the high temperature, corrosive, dirty environment in an automotive engine. Additionally, one of the planned uses in military aircraft, namely, on-engine flame detectors (i.e., in the engine during flight) is directly transferable to civilian aircraft. The development of improved epitaxial growth processes for SiC will be required to successfully commercialize these high temperature, high power devices.

REFERENCES:
"Mechanical Properties of Semiconductors and Their Alloys," SRI Inc., AD No: A231820.

AF96-159 TITLE: High Temperature Superconducting Thin Films

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop advanced thin film processes to enable fabrication of HTS devices for electronic, microwave and opto-electronic applications.

DESCRIPTION: Significant progress has been made in the fabrication of high-quality high temperature superconducting (HTS) thin films since the discovery of these materials. However, critical materials and processing issues still remain to be solved to fully use these films in a variety of device applications. Examples of issues considered appropriate for this program area include the following: (1) thin films which have lower loss, better power handling, and lower intermodulation products for advanced microwave devices, (2) uniformly high-quality HTS films in superconductor-insulator multilayers, (3) arrays of SNS junctions with junctions of optimized and reproducible properties, (4) tunable HTS microwave filters, and (5) integration of superconducting and semiconducting microelectronics. This topic addresses the development of materials and processing techniques which shall make practical use of superconducting materials in various electronic applications possible. Proposals should identify the potential application and its importance, identify the materials or processing problems which limit performance, and propose an innovative solution to these problems. Devices may be examined only for evaluating and demonstrating the techniques and materials which have been developed for successful fabrication of the devices.

PHASE I: Phase I will address process development and initial testing to demonstrate proof of concept. Delivery of a representative test sample or samples to the government is encouraged.

PHASE II: Phase II will develop and optimize the process or material to demonstrate the potential application and will plan for Phase III commercialization. Delivery of material samples to the government for testing is encouraged.

POTENTIAL COMMERCIAL MARKET: HTS materials technology has great potential for dual use and commercial applications. For example, HTS microwave filters could be used in cellular base stations to alleviate growing cellular interference problems and improve frequency utilization. HTS SQUID based systems may find applications in the medical field for measuring magnetic signals from the heart, brain, and other organs. SQUID magnetometers may also be used for

nondestructive testing of aging aircraft and other structural systems to find deep cracks and hidden corrosion.

REFERENCES:

1. "High-Temperature Superconducting Microwave Devices: Fundamental Issues in Materials, Physics, and Engineering," N. Newman and W. G. Lyons, Journal of Superconductivity 6, 119 (1993).

2. "Crystal Interface Engineering in High Tc Oxides," K. Char, MRS Bulletin 19 (9), 51 (1994).

AF96-160 TITLE: Electromagnetic Fire Suppression

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Quality/Civil Engineering
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop a fire suppression system based on the use of applied electro-magnetic fields.

DESCRIPTION: The use of chemicals to suppress fires has come under scrutiny in view of compliance with Montreal Protocol calls for reducing and halting the production of halogenated chemicals which are ozone-depleting. The search for halogen replacements has yielded some success in finding a suitable replacement for total flood or streaming applications. However, toxicity of some replacements is still an open issue. In light of these concerns, alternative methods which do not use chemicals are being sought to extinguish fires. The use of physical methods which are capable to extinguish fires has been shown to be a promising alternative. Specifically, the use of electrostatic fields has shown that pool fires can be effectively extinguished by using corona discharges. In addition, the diamagnetism of flame constituents can be used as an effective catalytic method to suppress fires. The USAF is seeking to develop a fire suppression system based on the principles of interactions of electromagnetic fields with flames which is safe, and practical to use in specific fire fighting environments. Applications are aimed at replacing existing total floods and streaming type agents. The overall objective is to design and fully test a device which could be utilized both in enclosed as well as open areas and serve as effective replacement to current fire suppressing chemicals.

PHASE I: Phase I research should require the design and testing of a small scale device which uses the principles of static or pulsed electromagnetic fire suppression to extinguish small area pool flames (30 cm2). The design should outline the generation and delivery of electromagnetic fields and a scale-up design. At the end of Phase I the contractor shall provide estimates on electromagnetic energy requirements for fire suppression in different scenarios.

PHASE II: Phase II should comprise the system design, fabrication and testing of a prototype fire suppression system capable of extinguishing large fires, including open as well as enclosed area fires. The final design should include the design of electromagnetic field delivery system including circuitry and other accessory systems.

POTENTIAL COMMERCIAL MARKET: The proposed fire-fighting system would have broad applications in the civilian community and thus a high potential for commercialization.

REFERENCES:

1. Jonas, L. A. and Steel, J. S. "Energy Fields for Fire Extinguishment" ESL-TR-90-11, Engineering and Services Laboratory, Air Force Engineering and Services Center, Tyndall AFB FL, August 1990.

2. Tapscott, R. E., May, J. H., Moore, J. P., Lee, M. E., and Walker, J. L., "Next Generation Fire Extinguishing Agent Phase II - Laboratory Tests and Scoping Trials," ESL-TR-87-03, Engineering and Services Laboratory, Air Force Engineering and Serices Center, Tyndall AFB, FL, April 1990.

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Laser-Induced Flame Propagation," "Combustion and Flame" 24, 159-167 (1975).
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13. Gulyeav, G. A., Popkov, G. A., and Shebeko, Y. N., "Synergism Effects in Combined Action of Electric Field and Inert Diluent on Gas-Phase Flames," "Fiz. Goreniya Vzryva" 23, No. 2, 57-59 (1987).

AF96-161 TITLE: Biodegradable, Direct Replacement Hydraulic Fluids for MIL-H-5606 and MIL-H-83282

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials, Processes and Structures
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop a biodegradable, direct replacement hydraulic fluid for use in aircraft operations.

DESCRIPTION: Current hydraulic fluid is not biodegradable. In normal ground aircraft operations, hydraulic fluid has the potential to enter the soil while work is performed with aircraft hydraulics. The waste hydraulic fluid becomes a contaminate when it enters the soil. Developing biodegradable hydraulic fluid would prevent a long term contamination effect. The fluid must be a direct replacement for MIL-H-83282 and/or MIL-H-5606 and must be capable of operation over the -40 deg C to 135 deg C temperature range. It also must be compatible and usable with current aircraft seals and system designs.

PHASE I: Investigate the development of substitute fluids. Review would include looking at previous work in this area. Demonstrate the feasibility of complying with critical property requirements.

PHASE II: This phase would involve materials development, toxicology assessment and a technical demonstration.

POTENTIAL COMMERCIAL MARKET: Biodegradable hydraulic fluids have an extremely large market. Examples of industrial equipment that could use the fluids are metal and plastic forming and processing equipment, mining equipment, elevators, fork lifts, etc. Other excellent candidate applications are: off-highway, agricultural and marine based equipment as well as brake fluids for automobiles, trucks, rapid transit systems, buses, trains, etc.

AF96-162 TITLE: Aero Propulsion & Power Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Aerospace Propulsion and Power

OBJECTIVE: Explore innovative approaches in structures, bearings, and lubrication concepts for gas turbine engines.

DESCRIPTION: The Aero Propulsion and Power Directorate aggressively pursues major performance advances in all components of gas turbine engines under the Integrated High Performance Turbine Engine Technology (IHPTET)initiative. Technologies derived under this initiative have resulted in higher thrust to weight ratios and improved efficiencies. The focus of this topic is to consider those aspects in the design of gas turbine engines that impact affordability and robustness without compromising the performance advances required. New analysis techniques, innovative designs and concepts for structures, bearings and lubrication systems for gas turbine engines are solicited.

PHASE I: Explore the feasibility of a new concept or concepts, through analysis or small scale testing to demonstrate the merits of the concept.

PHASE II: Provide detailed analytical derivations and prototypical device or hardware demonstrations.

POTENTIAL COMMERCIAL MARKET: The higher performance gas turbine engines and associated technologies will lead to more efficient, durable, and affordable commercial air breathing systems. Concepts developed under this program are suitable for integration into new engines for commercial use.

AF96-163 TITLE: Aircraft Electrical Power System Technologies for Existing Air Force Aircraft

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Propulsion and Vehicular Systems

OBJECTIVE: Explore and develop innovative electrical power system components applicable to existing Air Force fighter and transport aircraft.

DESCRIPTION: Proposed efforts should address the exploration and development of innovative electrical power system components for potential use on existing Air Force aircraft. The components should provide significant advancement over current design practices in terms of improved weight volume, reliability and cost. Candidate technologies include components involved in electrical power generation, distribution and control, and energy storage. Key technical hurdles in this area include fault tolerance, operational reliability under extreme conditions, electromagnetic compatibility, fault detection and integration.

PHASE I: Phase I goals include proof-of-concept experiments.

PHASE II: Phase II goals include demonstration of technical feasibility for the new technology and a thorough understanding of how the new technology provides substantial benefit over current practices.

POTENTIAL COMMERCIAL MARKET: Technologies involved in electrical power generation, distribution and control, and energy storage have broad-based applicability to a wide variety of military and commercial vehicles. Electrical power is being considered as the alternative power of choice versus combustion-driven power plants with hydraulic, pneumatic and mechanical power transfer and conversion subsystems. Conversion of vehicle power subsystems from the conventional complex hybrid approach to an electrically-based power subsystem is the focus of numerous military and industrial initiatives. Electrical power utilities companies could also benefit from the technologies developed under this topic.

RELATED REFERENCES:
"More Electric Aircraft," Richard E. Quigley, IEEE, 8th Annual Applied Power Electronics Conference, 19 March 1993, San Diego, CA.

AF96-164 TITLE: High Temperature, High Power Electrical Component Development

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Aerospace Propulsion and Power

OBJECTIVE: Research and develop high temperature (>300 degrees C), high power capacitor and semiconductor devices.

DESCRIPTION: Many military and commercial systems today are requiring high temperature electronics to run actuators, high speed motors, and generators. This is due, in part, to smaller system sizes operating at high performance levels. Future requirements place military system temperature levels at 300 degrees C or higher while at the same time improving performance capabilities. This can only be accomplished through improved power electronics. Two critical components in the power electronics area are capacitors and semiconductor devices. Not only must the temperature capability of these devices be raised to a minimum of 300 degrees C, but superior electrical performance is required. Novel material development for these power electronic devices are sought as well as innovative device design and packaging.

a. Develop innovative high temperature, dielectric material for AC/DC power filter and energy storage capacitors.

b. Develop a 4H- and/or 6H-SiC power electronic switch that offers an improvement in operating voltage, current, and temperature by a factor of 8, 2, and 3X, respectively, over existing Si power devices.

PHASE I: a. Demonstrate an innovative capacitor dielectric material with substantial improvements in dielectric constant, voltage breakdown strength, dissipation factor and temperature capabilities. Prototype laboratory scale capacitors should be fabricated and tested to show feasibility. b. Fabricate and characterize a SiC/insulator/metal structure exhibiting a breakdown field strength in excess of 10^7 V/cm and a surface state density less than 10^{10} V/cm. Predict the SiC VMOSFET device operating temperature versus device power level and amount of device active cooling. Identify, fabricate, and evaluate candidate high temperature packaging materials for use by the SiC VMOSFETs operating at above 300 degrees C.

PHASE II: a. Demonstrate development of large-scale prototype capacitor components using innovative dielectric material. Actual application testing should be performed and electrical, thermal and life assessments made. b. Demonstrate the fabrication of a 600V, 10 amp package SiC VMOSFET for operation at 300-500 degrees C.

POTENTIAL COMMERCIAL MARKET: Capacitors are used in nearly every commercial and military system. Some potential applications include medical defibrillators, high temperature power supplies, oil well drilling, numerous automobile applications, electric utilities, etc.

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AF96-165 TITLE: Cooling of Aircraft Components

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Aerospace Propulsion and Power

OBJECTIVE: Explore and develop cooling systems for high speed rotating machinery, actuators, and power electronics.

DESCRIPTION: Proposals should address the development of cooling systems for high speed rotating machinery, actuators, and power electronics, all of which have been shrinking in size and are increasing in power. Future trends will require motors/generators to be located inside of turbine engines where minimal cooling will be available. For these integrated power systems, oil cooling may not be an option. Generators will also shrink in size and will operate at high speeds where cooling air will cause windage problems. Possible solution approaches could include but, are not limited to the use of heat pipes, rotating thermosyphons, and fuel or spray cooling. Actuators impose a different cooling problem by virtue of being located in remote areas of the aircraft. In these cases, localized cooling schemes ar most desirable. However, consideration must be given to the circumstance where the temperature of local airfoil surfaces may momentarily exceed the safe operating temperature of the cooled device. Finally, novel high heat flux cooling schemes, preferably utilizing available on-board coolants, are sought for the cooling of high power electronics. Systems using different coolants should be conceived as line replacement units (LRU) to reduce maintenance and logistics costs. Reduction of initial cost, maintenance and logistics costs should be considered a key objective for all proposed development efforts. Operation of any proposed cooling device in the high g-force, high vibration environment of a modern military aircraft should also be addressed.

PHASE I: Develop a detailed technical definition of the problem, demonstrate key technologies, and identify proposed solution.

PHASE II: Concentrate on development of prototype components, subsystem demonstrations, and hardware development.

POTENTIAL COMMERCIAL MARKET: This technology has application for all commercial high speed motors, generators, actuators and power electronics which may be found in future electric/hybrid transportation (commercial air, high speed rail, and electric car), power generation, and manufacturing facilities.

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1. Abdel-Hakim, M. and Abdel-Aziz, M.M., "Thermal Modeling of Electrical Machines Cooled by Heat Pipes," Modeling, Simulation and Control, Vol. 6, No. 2, 1986, pp. 47-55.
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AF96-166 TITLE: Cryogenic Power Converter

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Aerospace Propulsion and Power

OBJECTIVE: Develop a prototype 50-kW dc-to-ac power converter module capable of operating in a cryogenic environment (20K - 77K).

DESCRIPTION: Several cryogenic power devices developed to date, such as the cryogenic aluminum generator and superconducting magnetic energy storage (SMES) systems. These devices have the potential of being used in various military or commercial applications. Some applications require a dc power source, while other applications require an ac power source. A power converter is required to use these devices to feed ac or dc applications. To date the power converters developed have operated at room temperature or above and have required careful designing to handle thermal loads. The final design of existing converters tend to be several times larger in size and weight when compared to cryogenic power devices. By designing the power converter to operate at cryogenic temperatures (20K - 77K) the overall size and weight can be considerably reduced while the efficiency can be increased.

PHASE I: Demonstrate a power converter operating at cryogenic temperatures capable of handling 1 - 10kW compatible with 60Hz power systems. This demonstration can be accomplished with a cryogen to cool the converter (e.g., liquid nitrogen) and the temperature of operation need not be optimized.

PHASE II: Demonstrate a 50-kW power converter operating at cryogenic temperatures compatible with 60Hz power systems. This demonstration should be accomplished using a cryocooler refrigerator to cool the device and the operating temperature should be optimized for efficiency.

POTENTIAL COMMERCIAL MARKET: The cryogenic power converter has potential use in lightweight airborne and ground based applications in the military and commercial sector. Military applications that can benefit from this technology are airborne radar systems, ground based lightweight portable power, and uninterruptable power systems (UPS). Commercial UPS and other applications that require large dc-to-ac power converters can benefit from the reduced size and weight and increased efficiency that this technology can offer.

REFERENCES:
1. Blanchard, R., "Designing Switch-Mode Power Converters for Very Low Temperature Operation," Proceedings Powercon 10 (1983) D2,1-11.
2. Mueller, O., "On Resistance, Thermal Resistance and Recovery Time of Power MOSFETS at 77K," Cryogenics, Vol 29, #10, Oct 1989, pp 1006-1014.
3. Severns, R., "Superconductivity and Low-temperature Power Converters," Powertechnics Magazine (1988) 4, p. 32-34.

AF96-167 TITLE: High Mach Combined Cycle Engine Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop key technologies for combined cycle engines operating from Mach 0 to 6.

DESCRIPTION: Investigations of combined cycle propulsion systems have shown turboramjets (TurboRJ), air-turborockets (ATR), and pulsed detonation engines (PDE) to be attractive propulsion concepts at Mach 0 to 6 flight speeds. TurboRJ and ATRs combine the flexibility and efficiency of turbomachinery at flight speeds of Mach 0 to 4 with the simplicity, low weight, and high specific impulse of the ramjet in the Mach 3 to 6 flight range. PDEs combine the simplicity and efficiency of the detonation wave combustion with the capability of air breathing at flight speeds of Mach 0 to 4 and rocket operation in the Mach 4+ flight range. Currently, plans underway to develop technologies for integration into TurboRJ, ATR, and PDE combined cycle propulsion systems. Examples of technologies which are of interest include air intake systems; exit nozzles; solutions to

reduce total pressure drag; innovative ignition methods; solutions to reduce the length and weight of the inlet, nozzle and combustor components; ramburner structures; ramburner fuel injection/flameholding schemes; endothermic fuel reactor/engine integration; heat exchangers; ramburner cooling techniques; and solid fuel gas generator fueling systems. Proof-of-concept testing is preferred, but analytical investigations will also be considered.

PHASE I: The goals will be to identify a novel concept, quantify its payoff when integrated into the selected combined cycle propulsion system, and conduct a small-scale experiment to demonstrate concept feasibility. If a strictly analytical approach is proposed, sufficient analysis must be performed to demonstrate some degree of concept feasibility and plan experiments for Phase II.

PHASE II: Larger scale development would be undertaken in Phase II. The proposal should include plans for Phase II testing, which would include identification of appropriate facilities. The goals of Phase III would be to integrate the components developed in Phase II into a combined cycle engine demonstrator and evaluate its performance.

POTENTIAL COMMERCIAL MARKET: Combined Cycle Engines are applicable to a multitude of vehicles which require efficient acceleration and cruise capabilities. Military applications might include long-range, high speed aircraft for reconnaissance and strike missions, stand-off missiles, and drones. Commercial applications might include high-speed civil transport or passenger aircraft. Dual use applications include military/commercial space launch vehicles which require an airbreathing propulsion system for the initial atmospheric boost phase. The PEGASUS launch vehicle and similar systems could benefit from the use of airbreathing boost propulsion.

REFERENCES:
1. Kay, I. W., Peschke, W.T., and Guile, R.N., "Hydrocarbon-Fueled Scramjet Combustor Investigation," AIAA-90-2337.
2. Roble, N.R., Petters, D.P., and Fisherkeller, K.J., "Further Exploration of an Airbreathing Pegasus Engine," AIAA 93-1832.

AF96-168 TITLE: Diagnostics Development for Supersonic Combusting Flows

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop nonintrusive diagnostic instrumentation and/or measurement techniques for use in supersonic/subsonic combustion flows.

DESCRIPTION: Obtaining accurate measurements of various parameters in a combusting flow field without disturbing the flow is a difficult task. Various optical "flow" diagnostics techniques are currently under development with the intent that it will eventually be used in a test cell environment versus laboratory conditions. The need still exists for the development of new techniques, or refinement of the currently available techniques to allow accurate measurements of the velocity, temperature, density, fuel concentration, and the constituency of the exhaust effluence for hydrocarbon and hydrogen fueled propulsion systems. Both statistical and time-averaged measurements are required to allow validation of analytical predictions.

In order to assess the performance potential of supersonic combustors "engines" or various engine components, new instrumentation and associated measurement techniques are also required. In particular, the development of microscale high response (greater than 50 kHz) optical sensors and methods for measurement of wall pressure, temperature, skin friction, and heat transfer rate capable of surviving the severe combustor environments is highly desirable. The instrumentation and associated measurement techniques proposed must be hardened to withstand harsh test cell environments and require only minimal pre- and post-test calibration. It is anticipated that a complete operating system to be used in a government supersonic combustion test facility would be a deliverable item at the end of Phase II effort.

PHASE I: Develop and refine the measurement technique and/or the instrumentation concept to allow proof-of-concept demonstration in representative supersonic and subsonic research combustors.

PHASE II: Develop the instrumentation and the associated measurement techniques to a point where it could be easily used in realistic combustor temperature and pressure environment under realistic flow conditions.

POTENTIAL COMMERCIAL MARKET: Potential for dual usage is great. Similar if not identical instrumentation and measurement techniques are required in automotive engineering and commercial aerospace industry. Commercial success is, however, dependent on sensor/instrumentation durability, practicality, accuracy, and cost. The intensive technology requirements and relatively long system development time period forces the small businesses to look to the government agencies and the national laboratories for partnership and investment. There is, however, a great market in the U.S. and abroad for

commercialization of optical measurement sensors.

REFERENCES:
1. Parker, T.E., et al., "Optical Diagnostics in Supersonic Combusting Systems," WL-TR-91-2101 (ADA-253463).
2. Chadwick, K.M., et al., "Direct Measurement of Skin Friction in Supersonic Combustion Flow Fields," ASME-92-GT-320.
3. Hager, J.M., et al., "Experimental Performance of a Heat Flux Micro-sensor," ASME-92-GT256.
4. Schetz, J.A., Billig, F.S., "Flow Field Analysis of a Scramjet Combustor with a Coaxial Fuel Jet," AIAA, Vol 20, pp 1268-1274, September 1982.
5. Van Driest, E.R., "The Problem of Aerodynamic Heating," Aeronautical Engineering Review, Vol 15, pp 2641
6. Winter, K.G., "An Outline of the Techniques Available for the Measurement of Skin Friction in Turbulent Boundary Layers," In Progress in Aerospace Sciences, Vol. 18, pp 1-57, 1977.

AF96-169 TITLE: Environmentally Benign Aviation Lubricants

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Quality/Civil Engineering

OBJECTIVE: Develop technology to minimize hazardous waste in life cycle of aviation lubricants.

DESCRIPTION: In producing, utilizing, consuming, and disposing of aviation lubricants, there is a continual interaction with the environment. Lubricants are products of petroleum refining or are produced synthetically. These materials are often stored and used for long periods of time. In use, lubricants degrade chemically but are not consumed. Disposal of used lubricants is a persistent problem. This topic seeks technology to reduce hazardous waste and pollution associated with the life cycle of aviation lubricants. Examples of technologies that fall within this description are:
- Lubricant performance additives that are environmentally benign
- Specification test methods that do not use volatile organic compounds (VOCs) and ozone depleting compounds (ODCs)
- Detection of adulterated lubricants
- Incineration strategies that minimize pollution formation in the effluent
- Separation techniques for isolating hazardous chemicals from otherwise nonhazardous oil waste
- Environmentally benign techniques for recycling or disposing of spent lubricants

PHASE I: Identify technology that could make the life cycle of aviation lubricants more environmentally benign and assess the impact on Air Force operations of using the technology.

PHASE II: Demonstrate and document the environmental advantage of the proposed technology, the extent to which weapon system performance and cost would be impacted, and the implementation path for the new technology.

POTENTIAL COMMERCIAL MARKET: Environmental control technology for military aviation lubricants would be directly applicable to the commercial sector. There is a large overlap between military and commercial aviation lubricants. Therefore, technology that minimizes negative environmental impact from the production, use, and disposition of such materials is directly applicable to both user communities.

REFERENCES:
1. Centers, P.W., "Potential Neurotoxin Formation in Thermally Degraded Synthetic Ester Turbine Lubricants," Arch. Toxicol., 66, 679-680 (1992).
2. Micallef, R.A. and A. Squires, "Characterization of Used MIL-L-7808 Lubricants," Air Force Technical Report AFWAL-TR-85-2017 (AD-A158624).
3. Waste Oil Reclamation (Feb 70-Present), NTIS Order No. PB94-854312, Dept of Commerce, Washington DC, 5285 Port Royal Road, Springfield VA 22161.
4. Barnard, J.A., Bradley, J.N., Flame and Combustion, 2nd Edition, New York NY, Chapman and Hall, 1985, pp 266-276, Wiley and Sons, 1986.

AF96-170 TITLE: Laser Diagnostics for Characterization of Practical Combustor Hardware

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Propulsion and Energy Conversion

AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Demonstrate advanced, laser-based concepts for measuring key combustion parameters under gas-turbine operating conditions.

DESCRIPTION: A principal driving force in the continuing development of advanced gas-turbine combustors is the reduction of environmentally hazardous emissions. Emerging gas-turbine design methodologies increasingly seek to achieve this low-emissions goal through computational fluid dynamics and chemistry (CFDC) codes. The successful performance of these codes is predicated upon experimental validation through measurement of key combustion parameters. This topic seeks advanced, non-intrusive, laser-based diagnostics capable of accomplishing these measurements under operating conditions characteristic of actual gas-turbine engines. Techniques which provide multi-dimensional images and/or time-resolved point measurements will be particularly advantageous for model validation. Rapid, repetitive measurements in turbulent flowfields will provide key statistics required to refine and improve CFDC turbulence models.

PHASE I: Experimentally demonstrate on a laboratory scale the potential of an advanced diagnostic concept to provide improved measurement of key combustion parameters compared to existing state-of-the-art methodologies. Modeling and other computational support of the concept is advantageous but not sufficient for a Phase I effort. Challenges to address include but are not limited to high pressure, optical thickness, scattering interference, and extreme environmental conditional (heat, vibration, etc.) characteristic of combustion in actual gas-turbine hardware.

PHASE II: Provide complete demonstration and documentation of the performance gains associated with the advanced diagnostic concept. Ideally, this demonstration would be achieved in conjunction with a combustion application of interest to the Air Force.

POTENTIAL COMMERCIAL MARKET: The gas-turbine design methodologies validated through these advanced, laser-based diagnostics will have tremendous impact on the future of both military and commercial aviation, particularly as these techniques contribute to the reduction of emissions. The diagnostic techniques have great dual use commercialization potential as well. The market for this equipment includes many university, government, and industrial researchers who require advanced diagnostics to make measurements under extreme conditions.

REFERENCES:

Goss, L.P. and Switzer, G.L., "Combustion Diagnostic Development and Application," WRDC-TR-90-2094, Nov 1990, DTIC Accession Numbers AD-A231 2667 (Volume l) and AD-A231 493 (Volume 2).

AF96-171 TITLE: Hybrid Magnetic/Gas/Rolling-Element-Bearing Rotor Support System

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Aerospace Propulsion and Power

OBJECTIVE: Development and verification of computer models for rotor dynamics for magnetic bearing and auxiliary support systems.

DESCRIPTION: Studies of active magnetic bearing systems have shown the potential payoffs and high risks involved in the development and application of this technology for advanced aircraft gas turbine engines. Active magnetic bearings represent an innovative approach to aircraft engine rotor support with the potential of providing significant benefits not possible with conventional rolling element bearings. The successful application of magnetic bearings would result in engines with no oiling systems, high rotor speeds, reduced blade tip and seal clearances, reduced weight, and enhanced rotor dynamic control. Auxiliary rotor support systems are expected to be necessary for successful application in an aircraft gas turbine engine. In order for a magnetic bearing rotor support system to be successfully used in an aircraft gas turbine engine, auxiliary/backup rotor support systems are expected to be required. A design and integration tool is also required to enable designers to design this type of complicated rotor support system for engines. Development of that tool is the goal of this program. The computer codes and verification vehicles (rigs) under this topic are to be targeted to design and analyze a gas turbine engine rotor system for fighter aircraft. The primary rotor support system to be analyzed and verified will consist of active magnetic bearings operating in conjunction with gas (or foil gas) bearings and incorporating rolling element bearings with ceramic rolling elements as backup protection. The verified tool shall be able to design and analyze a rotor support system capable of handling loads (steady and transient) due to severe aircraft maneuvers, compressor or turbine blade loss (failure) and dynamically transitioning between the three support systems i.e. magnetic, gas and rolling element. The tool shall be developed and verified to analyze the rotor

operating through and above the first bending critical speed (3rd critical speed) of the rotor. Other systems of auxiliary bearings that may be conceived which show promise for enabling introduction of magnetic bearings into future high temperature gas turbine engines may also be incorporated into the model and test verified.

PHASE I: Shall include development of the computer model and analysis codes for the system defined above and identification and preliminary design of the rig(s) to be used in Phase II for an extensive and thorough verification of the model. Some initial verification demonstrations in Phase I would also be desirable.

PHASE II: The goals will be extensive and thorough verification and further refinement of the design and analysis models developed in Phase I. As a minimum, rig testing will be conducted on a rotor system as defined above i.e. magnetic, gas, rolling element. The testing should be designed to verify all the requirements defined above.

POTENTIAL COMMERCIAL MARKET: A robust backup system for magnetic bearings and the design tool to introduce it into commercial designs would enhance current magnetic bearing commercial uses and enable new ones.

REFERENCES:
1. Hibner, David and Rosado, Louis, "Feasibility of Magnetic Bearings for Advanced Gas Turbine Engines," Int'l Symposium on Magnetic Suspension Technology, August 19-13, 1991, NASA Conf Publication 3152.
2. Meeks, C.R., Dirusso, E., Brown, G., "Development of a Compact, Light Weight Magnetic Bearing," AIAA Preprint 90-2483, presented at AIAA/SAE/ASME/ASEE 26th Joint Propulsion Conf., July 16-18, 1990 Orlando FL.

AF96-172 TITLE: Compression System Design Methodology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Aerospace Propulsion and Power

OBJECTIVE: Develop and advance the aerodynamic/mechanical state of the art in compression and secondary flow systems.

DESCRIPTION: A major trend in compression system hardware is the increased utilization of low aspect ratio blading, solid or hollow blisks, and three-dimensional design methodology. The primary and secondary flow system design capability which is currently two-dimensional must be extended fully into three dimensions to adequately exploit these trends. Areas of prime technical importance include blade/vane sweep, shock/boundary layer interaction, endwall and secondary flows, time unsteadiness, forced response and mistuning in compression systems, and innovative diagnostic instrumentation. Areas of particular interest in secondary flow system design include counter-rotation, trenching, brush seals, and disk pumping in regions as far back in the engine as the turbine shroud area.

PHASE I: Phase I will result in concepts for the development of advanced compression system or secondary flow system design.

PHASE II: Phase II will result in bench tested technology concepts or software compatible with unix based or MS-DOS based computer systems for advanced compression system or secondary flow system design, adequately documented to be acceptable to the technical community.

POTENTIAL COMMERCIAL MARKET: All commercial gas turbine engines require compression and secondary-flow systems. The improvements gained in compression and secondary flow system performance and efficiency will therefore directly benefit commercial turbine engines helping United States engine manufacturers to maintain superiority in the global commercial engine market. Performance and efficiency gains would also translate into monetary savings for commercial airlines by reducing fuel consumption.

REFERENCES:
1. Bullock, R., and Johnson, I., Aerodynamic Design of Axial-Flow Compressors, "Chapter III - Compressor Design System," NASA SP-36, 1965.
2. Moore, A., "Gas Turbine Engine Internal Air Systems-A Review of the Requirements and the Problems," ASME Paper 75-WA/FT-1, November 1975.
3. Ferguson, J.G., "Brushes as High Performance Gas Turbine Seals," ASME 88-GT-182, June 1988.

AF96-173 TITLE: Aircraft Turbine Component Technology - Aerodynamics and Cooling

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Aerospace Propulsion and Power

OBJECTIVE: Develop concepts for improving aerodynamic performance and reducing cooling flow requirements of turbine components.

DESCRIPTION: Address the development of aircraft engine turbine component technologies in the area of aerodynamics and heat transfer. A major trend in turbine components for aircraft engines is increased loading, increased turbine inlet temperature and reduced cooling air. New design concepts and analysis techniques along with experimental test methods are needed to further the technology in these areas. Proposals should focus on effort that contributes to meeting the goals of the Integrated High Performance Turbine Engine Technology (IHPTET) program.

PHASE I: Explore the feasibility of a new concept or concepts, through analysis or small scale testing, to demonstrate the potential merits of the concept.

PHASE II: Provide detailed analytical derivations, prototype and/or hardware.

POTENTIAL COMMERCIAL MARKET: Higher performance turbine engines and associated technologies will lead to more efficient, quieter and environmentally acceptable propulsion systems. Turbine technology improvements play a major role in military applications and there is great potential to transition to commercial use.

REFERENCES:
Simoneau, Robert J. and Simon, Frederick F., "Progress Towards Understanding and Predicting Convection Heat Transfer in the Turbine Gas Path," International Symposium on Heat Transfer in Turbomachinery, Athens, Greece, August 1992.

AF96-174 TITLE: Probabilistic Methods for Structural Management of Gas Turbine Engines

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Aerospace Propulsion and Power

OBJECTIVE: Develop a general-purpose finite-element based probabilistic analysis package for gas turbine engine structural applications.

DESCRIPTION: Unlike the transitional deterministic design methods, probabilistic analysis and design can quantify risk and thus identify areas of possible overdesign or conservatism in gas turbine engine applications. Additionally, probabilistic design can optimize components to be robust yet lightweight and can reduce costs when applied to the manufacturing and inspection process. While specialty programs have been developed for probabilistic design, they are generally hard to use, do not work with commercially available analysis codes, and their transition into the aerospace industry and community is therefore difficult. To promote more widespread use of probabilistic design in aerospace, a more general purpose computer code is needed. This probabilistic analysis and design code should be rapid, easy to use, accurate, and most importantly, compatible with commercially available finite element analysis codes. The aim therefore is to develop a computer program which can be integrated with a material modeling software and an existing commercial general-purpose finite element (FE) structural analysis computer program (e.g., ANSYS, NASTRAN) to form a general-purpose FE-based probabilistic computer program for large-scale nondeterministic structural analysis and design of gas-turbine engines. The probabilistic package would provide the basis for modeling uncertainties, computing probabilities and performing sensitivity analyses; the material modeling software would provide the means to interface with commercially available or user defined material databases and life prediction algorithms; and the FE software would provide the necessary computational framework for analyzing complex structures. The probabilistic package would then be capable of performing reliability and sensitivity analyses at component and system levels for non-normal dependent random variables and random fields using first-order second-moment methods, first-/second-order reliability analysis methods, response surface methods and simulation methods. The material modeling software would need to include fatigue, creep and fracture mechanics life prediction and the integrated package would need to be capable of performing static and dynamic analyses. In addition to user-friendliness, other features such as graphic interfaces, on-line help, parametric description of model and random variables and a description of the probabilistic analysis and design process as it relates to computer code will be key ingredients of the package.

PHASE I: Technology demonstration by partial development of the probabilistic package and partial integration of

this package with an existing commercial general-purpose FE package for static analysis. Demonstration of the capability by performing a probabilistic analysis on a structural component such as a disk.

PHASE II: Full development of the probabilistic software and material modeling software and integration of these software with an existing commercial general-purpose FE package for static and dynamic analyses.

POTENTIAL COMMERCIAL MARKET: Although this software would be developed for gas-turbine engines, the technology would have technical leverage which could be applied to many industries. The technology which would be developed and demonstrated during this program would have major benefits to all industries that incorporate it into specifications and design practices. The development could have a far reaching influence in the fields including, but not limited to structures, analysis and design, manufacturing, electronics, thermal, propulsion, and materials in the aerospace, automotive, nuclear, oil and construction industries with benefits to both industry and government.

REFERENCES:

1. Adamson, J.D., "The Probabilistic Design System Development Experience," 35th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, Hilton Head SC, 18-20 April 1994, AIAA-94-1444-CP.

2. Fox, E.P., "The Pratt and Whitney Probabilistic Design System," 35th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, Hilton Head SC, 18-20 April 1994, AIAA-94-1442-CP.

AF96-175 TITLE: Sensing Surface Temperatures of Ceramic Matrix Composites (CMC) Materials

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Aerospace Propulsion and Power

OBJECTIVE: Develop a practical method for sensing surface temperatures of CMC materials for advanced gas turbine engine combustors.

DESCRIPTION: Meeting the Integrated High Performance Turbine Engine Technology (IHPTET) Phase III engine temperature goals will require the development of CMC materials for use in the combustor section. To optimize their use, a better understanding of how CMCs respond to changes in their ambient temperatures is required. Finding a sensing device to do this monitoring will be a big challenge for a number of reasons. (1) The temperature sensor must give accurate readings while operating in a very high temperature and pressure environment. (2) If an adhesive is used to attach the sensor to a CMC surface, it must be able to withstand very high temperatures and pressures without significant loss of properties. (3) Both the sensor and the adhesive must be able to survive the test environment long enough for the tester to obtain useful data. (4) If a remote sensing system is developed which does not involve direct exposure of the sensor to the test conditions, it must be able to access the test surface without degrading the health and safety of the other parts of the test rig. (5) Any temperature sensing system that is developed for this purpose must be compatible with the data handling devices currently in use in the engine companies' test facilities.

PHASE I: Develop a means to measure CMC materials' surface temperatures under conditions that are similar to those found in a high pressure combustor rig.

PHASE II: Demonstrate the method developed in Phase I in an actual high pressure combustor test rig.

POTENTIAL COMMERCIAL MARKET: May be used in the development of CMC components for high temperature commercial applications such as supersonic jet transports.

REFERENCES:

1. "Two-dimensional Temperature Mapping Using Thermographic Phosphors," Conference Proceedings, Spring Meeting of the Electrochemical Society, Montreal, Canada, 6-11 May 1990 (NTIS # DE90011954/XAB).

2. "Evaluating and Testing Thermographic Phosphors for Turbine-Engine Temperature Measurements," Conference Proceedings, AIAA/SAE/ASME/ASEE Joint Propulsion Conference, San Diego CA, 29 June 1987 (NTIS # DE7011772/XAB).

AF96-176 TITLE: Hypervelocity Vehicle Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Aerospace Propulsion and Power

OBJECTIVE: Develop technologies for improving hypersonic vehicle performance and design capabilities.

DESCRIPTION: Research and development in hypersonic flight technologies, including supersonic combustion ramjet (SCRAMJET) technology, aimed toward engine performance and airframe-propulsion system integration. Computational fluid dynamics, materials and coatings,structural design and structural cooling, control systems, and integrated vehicle performance are of special interest.

PHASE I: Identify novel concepts, estimate their payoffs, and conduct small-scale experiments as appropriate to demonstrate concept feasibility. If a strictly analytical approach is proposed, it must demonstrate some degree of concept feasibility and show a logical progression to Phase II. Provide detailed drawings, specifications, and test procedures for the proposed application of the technologies.

PHASE II: Phase II should yield prototype and associated test results demonstrating decreased weight, increased scramjet performance, or improved aerodynamic design tools without increased cost and complexity. The proposal should include plans for prototype and component testing, to include identification of appropriate facilities. The goals of Phase III would be to integrate the components developed in Phase II into a performance demonstrator.

POTENTIAL COMMERCIAL MARKET: The propulsion, materials, and computer technologies developed would have application to a multitude of military and commercial vehicles, e.g. long-range, high speed aircraft for reconnaissance and strike missions, stand-off missiles, drones, high-speed civil transport or passenger aircraft. Government laboratories, the computer industry, the automotive industry, and commercial aircraft manufacturers, would also be potential customers for materials, CFD, and software.

REFERENCES:

1. "X-30: Out of This World in A Scramjet," Popular Science, vol. 239, No.5, November 1, 1991.
2. Schetz, J. A., and Billig, F. S., "Flow Field Analysis of a Scramjet Combustor with a Coaxial Fuel Jet," AIAA Journal, vol 20, pp 1268-1274, September 1982.
3. Leving, A. U. and Narendra, K. S., "Control of Nonlinear Dynamical Systems Using Neural Networks: Controllability and Stabilization," IEEE Transactions on Neural Networks, vol. 4, No. 2, pp 192-206, March 1993.
4. Stevens, D. R., "Practical Considerations in Waverider Applications," AIAA Paper AIAA-92-4247, August 1992.
5. Messersmith, N.L. and Dutton, J. C., "An Experimental Investigation of Organized Structure and Mixing in Compressible Turbulent Free Shear Layers," University of Illinois at Urbana-Champaign, UILU-ENG-92-4002, 1992.

AF96-177 TITLE: Joining Methods for Organic Matrix Composites

CATEGORY: Basic Research
DOD TECHNOLOGIES: Manufacturing Sciences and Technology (MS&T)

OBJECTIVE: Develop structural joining methods for field assembly of organic matrix composites.

DESCRIPTION: Decreasing defense budgets along with increasing commercial requirements necessitates the development of low cost organic matrix composite structures. Affordability includes all steps of the manufacturing process from starting materials of final inspection. A large percentage of the costs are associated with assembly and repair of composite structures. Currently, there are no available joining methods that lend themselves to quick and easy field assembly and repair of aircraft composites. Joining concepts are required that (1) may be used under field conditions with a minimum of tools/equipment, (2) develop an adequate portion of the strength of the structural members themselves, (3) minimize or eliminate surface preparation, and (4) minimize the need for precise dimensional tolerances.

PHASE I: Demonstrate the feasibility of joining methods for organic matrix composites. The concept will be demonstrated by the fabrication of a composite structure utilizing the joining technology proposed.

PHASE II: Build upon the Phase I work to refine the concept, scale-up, and ready the concept for factory floor or field operations.

POTENTIAL COMMERCIAL MARKET: Composite materials have already found widespread application in the commercial market. Improved quality and lower part cost are desired features whether the market is military or commercial. The concept developed herein will be applicable and beneficial to industries ranging from defense and commercial aerospace, to automotive, civil structures, and electrical component industries.

AF96-178 TITLE: Create a Process Analysis Tool Kit for Affordability (PATA) Supporting the R&D Process

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Provide professional, easily used tools enabling life cycle performance, cost and schedule affordability analysis.

DESCRIPTION: Using a standard baseline engineering life cycle model, the offeror will develop an R&D Affordability Framework reference model containing specific life cycle domain architectures and their defined processes. The model development will support each phase and the intrinsic relationships of the specified system engineering methodology (per Std 499B and Handbook 499-3). The affordability reference model design will allow the user to apply rules to select various configurations of affordability methodology for use. These strategies will be technical compliance to the reference model, be complete and consistent, and execute with use application integrity. The offeror will analyze and determine the AFMC 499B & 499-3 (or commercial equivalent) requirements succinctly for each phase architecture, and the transition activities and mechanisms between each life cycle phase. The offeror will identify and document specific technical voids determined during the requirements analysis. The offeror will perform a survey and analysis of commercially available methods, tools, techniques, and equipment available that satisfies each of the specified requirements. The commercial off-the-shelf (COTS) technologies (hardware, software, and method ware), capability, cost, and supplier will be documented in a matrix. The offeror will test, validate, and demonstrate via a prototype the utility of an affordability framework reference model, its supporting architecture's using selected tools, methods, and techniques. The demonstration will use commercially available hardware (multiple platforms) and COTS software (i.e. DBMS, spreadsheets, applications, etc.) wherever possible to improve the widest possible affordability practice in R&D.

PHASE I: Goals: - Analysis standard life cycle models - Establish a standard compliant Affordability Framework - Establish standard compliant LC phase and transition architectures - Develop the PATA functional design specification - Perform the state-of-the-art affordability tools survey - Demonstrate the PATA, the Affordability Framework and the architectural utility - Develop monthly progress and final reports

PHASE II: Goals: - Develop product agreements with suppliers of affordability tools - Commercially package the Affordability Framework, architectures and application interfaces - Develop onboard computer based training (CBT) for PATA - Validate PATA's capability against Advanced Technology Projects - Develop PATA's marketing plan and packaging - Participate in major forums promoting PATA - Conduct Technical Review Board meetings every 8 mos. after start - Demonstrate PATA as a COTS product - Develop monthly, interim, and final reports

POTENTIAL COMMERCIAL MARKET: PATA is intended to be used by the science & technology community including industry, academe, and government ensuring that research and development projects have viable, usable and affordable results.

AF96-179 TITLE: Development of Affordable Integrated Optic Chips

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop manufacturing process improvements of an affordable pigtailed Integrated Optic Chip (IOC).

DESCRIPTION: The overall goal of the effort is to reduce the cost of pigtailed IOCs, which are a key component used in Fiber-Optic Gyros (FOGs), to less than $100 in large volume production (6000 Inertial Measurement Units (IMUs)/year). Offerors should target tactical and navigational grade applications. Proposals should address manufacturing improvements in the following areas: wafer/chip manufacturing, chip end face preparation, fiber preparation, fiber chip attachment, and packaging.

PHASE I: Offeror will develop a program plan and cost reduction model to detail how process improvements and cost reductions will be made. The program plan should include a variability reduction roadmap showing how tools (such as Design of Experiments (DOE), Quality Function Deployment (QFD), and Statistical Process Control (SPC)) will be used to obtain programmatic goals. The program plan should also include a process micro-flow documenting the current process and showing where improvements in yield, labor, and material will be performed. The offeror will need to demonstrate how this technology will be inserted into the FOG system houses. This phase should culminate in a feasibility demonstration to provide confidence in the approach.

PHASE II: Implement the process improvements proposed in phase I. Variability reduction will be a key part of this

phase, and the offeror will be required to show that the IOC processes addressed are under control by monitoring the process capability indices (Cp and Cpk). The program will provide for periodic process demonstrations to verify the progress towards the $100 per IOC cost goal. Deliverables to the government from these demonstrations should provide independent verification of program results as well as assurance that the IOCs will meet the tactical and navigational requirements of the IFOG system houses.

POTENTIAL COMMERCIAL MARKET: FOGs have numerous applications in both the commercial and military markets primarily in the area of navigation (for automobiles, airplanes, and ships). One US company is currently supply FOGs for a commercial airline, and the Japanese already have FOGs on cars.

AF96-180 TITLE: High Temperature Bagging and Sealant Materials for Composite Manufacture

CATEGORY: Basic Research
DOD TECHNOLOGIES: Manufacturing Sciences and Technology (MS&T)

OBJECTIVE: Develop bagging and/or sealant formulations for use with high temperature (>600F) curing of aerospace quality advanced composite structures.

DESCRIPTION: As temperature requirements continue to increase on DoD weapons systems, new materials have been developed which offer increased structural performance at elevated operational temperatures. However, these matrix systems are typically processed at temperatures greater than 600F and pressures of 200 psi and tend to degrade current ancillary processing materials such as bagging materials and sealants. This may cause failure of the bagging material or sealants during processing and may lead to poor part quality and increased costs. Also, as composite components become larger and more complex, bagging materials must be available in sufficiently large sizes to eliminate the need for seaming which can also lead to bag failures. The tooling required for larger parts also require longer heat up times which further increases the time the processing materials are exposed to elevated temperatures. In order to efficiently utilize organic matrix resins which process at elevated temperatures, production hardened ancillary processing materials must be available.

PHASE I: Demonstrate the feasibility of ancillary processing materials such as bagging materials and/or sealants which can withstand extended processing cycles at temperatures greater than 600F and 200 psi. The concept will be demonstrated by the fabrication of a composite laminate utilizing a high temperature organic matrix resin system such as AFR-700 or a thermoplastic resin which processes at temperatures greater than 600F.

PHASE II: Build upon the Phase I work to refine the concept, scale-up, and ready the concept for factory floor operations.

POTENTIAL COMMERCIAL MARKET: Composite materials have already found widespread application in the commercial market. Improved quality and lower part cost are desired features whether the market is military is military or commercial. The concept developed herein will be applicable and beneficial to industries ranging from aerospace to automotive to medical.

AF96-181 TITLE: Automated Methodology for Integrating Cost with Operational Effectiveness Analyses

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop an automated methodology which provides a marginal life cycle cost (LCC) analysis integrated with an operational effectiveness analysis.

DESCRIPTION: Currently, separate methodologies are used to determine the operational effectiveness and the associated life cycle cost (LCC) of various acquisition alternatives. Separate tools may lead to inconsistent assumptions and questionable results. The cost/effectiveness question draws on two basic types of analyses: mission area analysis (MAA) and marginal analysis. The MAA assesses alternatives in an operational context: they identify what force capabilities would be gained (or foregone) by pursuing any of a designated set of alternatives. The marginal analysis looks at changes in total costs (LCC) associated with changes in capability. An integrated, PC based tool which addresses both types of analyses will resolve the inherent weaknesses of the current approach. It should employ optimal technique algorithms to determine outcome (measure of outcome) and cost as the force mix is iterated as the dependent variable. This tool should operate at multi-levels. That is,

capable of conducting analyses when very little information is available for input and also when detailed information is available. Likewise, it should be useable for concept analyses (premilestone zero) as well as Milestone I, II & III type decisions.

PHASE I: The methodology will be designed and demonstrated. Key factors, operational requirements and cost considerations will be defined. The inter-play of the elements from the MAA and marginal analysis will be described. The approach will consider operational effectiveness, life cycle cost and the interaction between these two analyses and their key elements. The tool will address all operational phases of Milestones 0, 1, 2, 3, and all approaches; new system, modifications, technology insertion. The demonstration will involve a premilestone 0 scenario. The final output for Phase I will be a Software Design document for implementation of the model on a state-of-the-art PC.

PHASE II: The model will be developed, documented, demonstrated and delivered.

POTENTIAL COMMERCIAL MARKET: The product has applications to current and future aircraft modernization programs for both DOD and commercial aeronautical systems. This concept could be broadened to address analysis of commercial strategic planning, that is, the marginal change in company effectiveness within their industry with the attendant marginal cost of this change/decision.

REFERENCES:

1. AFMCP 173-1, Cost & Operational Effectiveness Analysis Handbook, Aug 92.
2. DOD Directive 5000.1, USD(A) Defense Acquisition, Part 1 - Policies Governing Defense Acquisition, Feb 91.
3. DOD Instruction 5000.2, Defense Acquisition Management Policies and Procedures, Feb 93.
4. DOD 5000.2-M, Defense Acquisition Management Documentation and Reports, COEA Analysis, Mar 93.

AF96-182 TITLE: Architecture and Tools for Processing Pre-Award Systems Acquisition Documents

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Computing and Software

OBJECTIVE: Develop software architecture/tools and integrate security techniques for electronic exchange of sensitive but unclassified procurement data packages (RFPs) and proposals.

DESCRIPTION: Technology and tools are required to automatically structure systems acquisition packages so they may automatically be parsed, reformatted, routed, and processed by integrated product teams using compatible tools. The government has developed modifications to the ANSI standard for EDI,X12. However, the transaction sets derived from this work are not truly useful for systems acquisitions. The problem has to do with the large textual content of systems procurement packages, in contrast to operational and small contracts. For example, only a human can accurately derive requirements from the statement of work--a computer system would have great difficulty parsing requirements from a systems RFP. Both the preprocessing (tagging) and postprocessing tools are needed. Finally, while DOD has developed standard techniques for the protection of classified electronic information, those techniques are too expensive, cumbersome, and unwarranted for the exchange of unclassified but sensitive data, e.g. proprietary information submitted as part of a proposal. Tools and techniques for secure exchange of procurement data is dependent on implementation of an adequate and economical solution to the security problem from both government and contractor points of view.

PHASE I: Develop the architecture; then design and demonstrate the feasibility of a toolset to:

1) Preprocess (tag) typical systems RFPs and proposals for transmittal in electronic format.
2) Postprocess those tagged documents for electronic distribution. This will include export/import of data to/from databases.
3) Provide best practice security for the protection of these documents during electronic exchange. Specifically, the security architecture will:

a) Comply with standards for digital signature and encryption
b) Be open--it must be easy to integrate with standard systems and software
c) Be economical to implement for both government and industry.

The tools should be designed for computer supported collaborative work (CSCW) or "workgroup" computing. Multiple users must be able to manipulate the same data. The tools should be compatible with the most commonly used government computer systems and software.

PHASE II: Develop the architecture and specific tools.

POTENTIAL COMMERCIAL MARKET: This architecture will improve industry's ability to quickly respond to RFPs by using the same toolset and architecture that the government uses to prepare them. The government's ability to produce structure

proposals will improve the quality of the procurement process from an industry perspective. Government and industry use of the tools will make EDI practical for systems acquisitions.

REFERENCES:
1. Decision Memorandum, Comptroller General of the United States, "NIST--Use of Electronic Data Interchange Technology to Create Valid Obligations," 13 Dec 1991.
2. ISO 8879, "Standard Generalized Markup Language", Federal Information Processing Standards Publication (FIPS PUB) 152, WL/STINFO Office, WPAFB OH.
3. NIST - "Secure Hash Standard", FIPS PUB 180, 11 May 1993
4. NIST - "Digital Signature Standard (DSS)", FIPS PUB 186, 19 May 1994.
5. ANSI X9.9, Message Authentication, WL/STINFO Office, WPAFB OH.

AF96-183 TITLE: Armament Research

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Conventional Weapons

OBJECTIVE: Develop innovative concepts in areas associated with air deliverable munitions and armaments.

DESCRIPTION: This is the general topic for the Wright Laboratory Armament Directorate. We are looking for new and innovative ideas/concepts and analytical methodologies, which have a good dual use/commercialization potential, in the area of air delivered non-nuclear munitions and armament, which is our mission. These include bombs, submunitions, warheads, projectiles, fuzes (including safe and arm devices), dispensers, seekers, explosives/energetic materials, carriage and release equipment, aerodynamic and structural technologies, fiber optics, solid-state inertial components, exterior ballistics, lethality/vulnerability and performance assessment techniques, test technology, modeling and simulation resources and techniques, and conventional weapon environmental demilitarization and disposal techniques. Some examples of desired research are: low drag/observable weapon airframes, conformal/internal carriage techniques, flow field optical image analysis, millimeter wave-seekers for mid-course and terminal guidance, sensor fusion, self-forging fragment warheads, shaped charges, long-rod penetrators, reactive fragment warheads, computational mechanics including interactive grid- generation techniques, and warhead hydrocode-assessment techniques, hard-target weapon/penetration technology, and autonomous guidance. Any proposal that is to be considered for a contract award submitted under this topic, must have good dual-use/commercialization potential.

PHASE I: During Phase I, the offeror shall determine the technological or scientific merit and the feasibility of the innovative concept.

PHASE II: The Phase II effort is expected to produce a well defined deliverable product or process.

POTENTIAL COMMERCIAL MARKET: Each proposal submitted under this general topic should have an associated dual-use commercial application of the planned technology. The commercial application should be formulated during Phase I. Phase II will require a complete commercialization plan.

AF96-184 TITLE: Endo Atmospheric Hypersonic Vehicle Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Air Vehicle/Space Vehicles

OBJECTIVE: Develop and collect tools and technology to allow design and manufacture of hypersonic vehicles.

DESCRIPTION: Hypersonic vehicles push technology in the areas of propulsion, aero/thermo heating, materials, guidance, and sensors. The design of advanced hypersonic vehicles requires integration of many of these technologies into a single, complex system. These vehicles offer significant improvements in vehicle survivability against protected defenses, enhanced warhead effectiveness due to kinetic energy exchange, improved response to enemy maneuvers, and ultimately a better cost/effectiveness ratio.

PHASE I: Phase I of this effort should: (1) investigate key hypersonic vehicle component technologies for future designs, (2) develop design tools for evaluating vehicle shape, size, and performance through simulation.

PHASE II: Phase II should involve: (1) vehicle component designs and evaluations; (2) fabrication of hypersonic

vehicle radomes, control surfaces, air frames, or other critical components; and (3) ground testing (i.e. wind tunnel tests, sled track tests) of one or more of the components.

POTENTIAL COMMERCIAL MARKET: The immediate results of this hypersonic research could impact work being done on the National Aerospace Plane (NASP), and other rocket and missile programs. The multiple technologies necessary to design and manufacture hypersonic vehicles, and the new developments in materials, propulsion, sensors, and optimization can have an immediate impact on the commercial world. This application will provide a test-bed for real-time application of the new research developments and provide feedback on their effectiveness.

REFERENCES:
Lawrence D Huebner, *Experimental Results on the Feasibility of an Aerospike for Hypersonic Missiles*, AIAA 95-0737(33rd Aerospace Sciences Meeting and Exhibit,Jan 9-12,1995)

AF96-185 TITLE: Miniaturized GPS Antenna Array Interference Resistance Concepts

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronic Warfare/Directed Energy Weapon

OBJECTIVE: Develop miniaturized affordable GPS antenna arrays.

DESCRIPTION: The Global Positioning System (GPS) is being exploited for tactical weapons via the Joint Direct Attack Munitions (JDAM). The navigation accuracy of GPS/IMU has improved weapon accuracy as evidenced in the Operational Concept Demonstration (OCD) program. However, there is an emerging threat to GPS/IMU guided systems that require effective and efficient jam resistance technologies. Current tactical antijam systems use beam/null steering antenna arrays and adaptive electronics. There are efforts in progress that address the size reduction and processing capability of the adaptive electronics. However, due to physical constraints for antenna designs, multi- element designs require a large surface area to be effective as a beam forming system. Array designs consisting of a minimum of four elements which are affordable and smaller than conventional designs are needed for future, smaller tactical weapons. Direct attack weapon scenarios are of primary interest.

PHASE I: Phase I of this project should investigate innovative antenna element and array designs on a six inch diameter surface area that allow beam/null forming.

PHASE II: Phase II should be the realization via procurement/fabrication of antenna array and supporting adaptive electronics.

POTENTIAL COMMERCIAL MARKET: The commercial airline industry plans to use GPS as a primary navigation device. Thus, the FAA is very interested in protecting the GPS reception of their landing systems and aircraft. Additionally the United States Coast Guard has shown interest in protecting their differential GPS stations.

AF96-186 TITLE: Optical Detection and Discrimination Techniques for Laser Radar

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop alternative detection and discrimination techniques useful for 3D range-imaging and/or range-doppler imaging with an emphasis on low-cost and manufacturable technologies.

DESCRIPTION: Laser range-imagers and laser radars are useful tools for a variety of applications such as remote-sensing, machine-vision, parts inspection, and others. Most existing laser radar systems rely on one of two schemes for finding the distance to an object; either a pulsed detection scheme which measures the photon-time-of-flight or a coherent detection scheme which measures the radio frequency beat noise of two interfering optical signals. Generally, these systems operate with a single element detector (or a linear array of such elements) combined with a scanning laser beam to assemble an image. Each of these systems has several drawbacks which limit their applications, particularly in areas where cost is of concern. One challenge is that the receiver must have a large dynamic range as the returned signal falls off as 1/R2 (in the best case), where R is the range to the object being imaged. This problem is exacerbated as the reflectance from various objects can range from 5% to 95%.

Current direct detection systems tend to have limited range resolution (inches) and are often limited by background noise, while current coherent systems tend to be complex and expensive. The use of a scanner often limits the data rate of the system as well as the environment in which it can be used. The area which can be searched by a system is limited by the required resolution and the data rate of the system.

Although these two basic designs concepts dominate the laser radar field, several variants of these systems as well as other system concepts are feasible. The goal of this topic is to explore and develop laser radars based on principles which promise a substantial performance improvement and/or cost reduction. Approaches which can increase the dynamic range of the receiver or can improve the range or angular resolution are of interest. Systems which take advantage of mass-produced detector technology (such as Change Coupled Device, CCDs) or which rely on previously unexploited optical properties (such as wavelength dependent properties) are also of interest. One possible example is to use modern, solid state technology to implement low cost coherent systems. An additional example is to use a laser radar that operates at tow wavelengths in the near infrared and ratios the returns at different wavelengths to increase the signal to noise. Yet a third example would be the implementation of a coherent receiver utilizing a CCD camera as the detector.

PHASE I: Phase I of this project would demonstrate the feasibility of the detection technique in a controlled environment. An investigation into the applicability of the technique to specific problems may also be appropriate.

PHASE II: Phase II would consist of the construction of a fieldable laser radar system which operates on the principles explored in Phase I.

POTENTIAL COMMERCIAL MARKET: This project would add new capabilities in the laser radar field that would benefit both the military and commercial industry, particularly in areas where current systems can not be used. A system with improved range resolution would enable automated parts inspection for manufacturing, as well as having possible medical applications for the measurement of burns and incisions. A scannerless system could enable the acquisition of data through fibers, which would allow remote inspection of cavities, crevices, and other structures.

REFERENCES:

1. W. Koechner, "Solid-State Laser Engineering," Springer-Verlag, New York, 1992. A. Jelalian, "Laser Radar Systems," Artech House, Boston, 1992. Electro-Optics Handbook, RCA Solid State Division, Lancaster PA, 1974.
2. W.L. Wolfe and G.J. Zissis, "The Infrared Handbook", Environmental Research Institute of Michigan, Ann Arbor, 1989.

AF96-187 TITLE: Active Infrared Optical Component Development

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Design and fabricate optical components with substantially improved performance at near-to-mid infrared wavelengths

DESCRIPTION: High-quality optical components useful in the near- to-mid infrared (IR) are essential for many applications, such as spectroscopy, remote sensing, LIDAR, and fiber optics communications. The performance of commercially available components in these spectral regions does not compare with that available from visible components and severely limits the applications which can be attempted. The following three areas illustrate the limitations faced in the near-to-mid IR region: lasers, avalanche photodiodes, and optical filters.

Mid-IR lasers are useful sources of optical power in applications where highly monochromatic, highly collimated optical sources are required. Currently, commercially available lasers at wavelengths of 1.4 microns or longer operate whether at low-power (less than 1 W average power) or at low-repetition rates (cw or less than 1000Hz).

Avalanche photodiodes (APDs) are useful detectors of optical signals in applications where both a high responsivity and a fast response time are needed. Currently, APDs have a limited range of wavelengths in which they are useful(less than 1.7microns). Silicon-based APDs are limited to operation below 1.1 microns. In GaAs based APDs can be extended performance out to 1.7 microns; however, they have much lower responsivity compared to Si. No APDs sensitive past 1.7 microns are currently available.

Optical bandpass filters are useful in applications where it is necessary to reduce unwanted optical noise around a particular wavelength. Currently, monochrometers can be used to obtain a band pass of less than one nm; however, they are prohibitively large and have too low a throughput for many applications. Compact bandpass filters are also available with a FWHM (full width half max) of 5 to 10 nanometers and peak transmission of less than 50 percent.

The performance of these components needs to be improved as they severely limit the systems which can be produced. The goal of this topic is to develop component technology in the following areas: lasers with pulse repetition frequencies exceeding 10kHz, pulse lengths of 10 ns or less, and average powers exceeding 2W; APD diodes sensitive at wavelengths greater than 1.5 microns with high responsivities (on the order of Si) and rise times on the order of 1 nanosecond or less; and compact bandpass filters with a bandpass of 1 nm or less and peak transmittance of greater than 50 percent.

PHASE I: Phase I of this SBIR task would be to demonstrate the feasibility of a component with the appropriate characteristics, and to produce a system design for a phase II construction. Experimental demonstrations of the high risk technology areas are desirable in this phase.

PHASE II: Phase II would involve the construction of the laser system and characterization of system performance. The final units could be coupled to other IR components to form a simple ranging system, or combined with more complex hardware to create systems which can monitor atmospheric constituents.

POTENTIAL COMMERCIAL MARKET: This project would fill a gap in current component capabilities that would benefit the military and commercial industry. An increase in the repetition rate for mid-IR lasers would allow systems using these lasers to operate in a real time eyesafe mode, while an optical filter with FWHM of 1 angstrom would dramatically increase the signal to noise ratio of systems based on current technology. An increase in the gain-bandwidth product for a detector in mid-IR would revolutionize several applications by reducing the requirements on laser power for many applications.

REFERENCES:

1. W. Koechner, "Solid-State Laser Engineering," Springer-Verlag, New York, 1992. A.A. Kaminskii, "Laser Crystals," Springer-Verlag, New York, 1990.
2. A. Jelalian, "Laser Radar Systems," Artech House, Boston, 1992 Electro-Optics Handbook, RCA Solid State Division, Lancaster PA, 1974.
3. W.L. Wolfe and G.J. Zissis, "The Infrared Handbook", Environmental Research Institute of Michigan, Ann Arbor, 1989.

AF96-188 TITLE: Alternative Passive Millimeter-Wave Imaging Camera

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop a low cost millimeter-wave radiometric camera with image frame rates of greater than one frame per second.

DESCRIPTION: A passive millimeter-wave imaging camera is in several ways a direct analog of the simple box camera commonly employed for taking photographs. It differs, however, in that an array of very sensitive millimeter-wave detecting elements is substituted for the film or photographic plate. A more significant difference is that a passive millimeter-wave camera can take pictures both day and night under conditions such as dense fog that would blind an ordinary camera. Current passive millimeter-wave cameras proposed for Autonomous Landing Guidance of commercial and military aircraft will be typically quite large and expensive. Since these systems will be installed in relatively fast moving aircraft, they must produce images at fairly high rates. There is, however, a vastly larger market, both military and commercial, for low cost all-weather, day/night imaging systems that need not take pictures at such a high rate. Some of these are inland water-way navigation; base, post, yard, and industrial complex security and surveillance; all rail, light aircraft, and highway transportation; and fire fighting. It's notable that these applications extend world wide. There are over a hundred thousand brush and forest fires in the United States alone each year with over thirty percent greater than ten acres in extent. A passive millimeter-wave sensor could allow pilots to see through dense smoke and flames so that they could fly and deposit fire suppressant materials directly on the sources of the flames. A further example of the remarkable penetrating power of passive millimeter-waves is that hot spots can be imaged through the walls of burning structures. These images could be used to greatly enhance fire fighting and search and rescue strategies. The derived goal for this SBIR program is to design and develop a very low cost, compact, passive millimeter-wave imaging sensor which addresses as many of the aforementioned applications as possible.

PHASE I: Phase I of this SBIR program should include justification and rationale for selection of an appropriate detector technology, description of a potential imaging scheme, and a preferred preliminary Phase II, overall system design.

PHASE II: Phase II should include building a prototype, proof of principal, passive millimeter-wave camera which can satisfy the low frame rate imaging requirements for at least several of the applications discussed above.

POTENTIAL COMMERCIAL MARKET: A passive millimeter-wave camera could provide a low cost, all-weather, day/night

imaging capability available from no other sensor. All military applications of such a system have their duals in the commercial world, and indeed, the extent of commercial application could be enormous.

REFERENCES:

1. J. Browne, "MM Waves Aid Commercial Applications," Microwaves & RF, Vol 31, No 7, pp 113-116, Jul 1992.
2. R. M. Smith, et al, "Passive Millimeter Wave Imaging (PMMWI)," Proc. IRIS Passive Sensors, Vol 1, pp 233-242, 1994.
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AF96-189 TITLE: Laser Scanning Techniques

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Design, fabricate, and demonstrate innovative methods of light weight, low cost laser radar scanning.

DESCRIPTION: Imaging laser radar (LADAR) sensors require a method of scanning laser energy. Several methods are available including rotating mirrors, scanning mirrors, binary optics, and liquid crystals. Currently, there are limitations with all scanning methods. An ideal scanner would have few or no moving parts. It would scan in two dimensions, up to 45 degrees in both directions, and steer the transmit and receive optics. In an active laser radar, the scanner can operate on a single wavelength. Present systems use near infrared wavelengths around 1.06 microns. A successful solution would be adaptable to longer, eyesafe wavelengths of 1.54 microns or greater. The scanning accuracy should be greater than 0.1 mrad and should scan an entire frame in less than a second. Additionally, the scanner should be able to communicate its position to a computer with high, repeatable accuracy.

PHASE I: Phase I of this project would investigate and select a candidate scanning technology. The areas of greatest technological risk would be identified. Finally, a detailed research plan and physical layout would be accomplished.

PHASE II: Phase II would involve enacting the research plan developed in phase I. A prototype scanner would be constructed and integrated into a laboratory breadboard system at the LADAR Development and Evaluation Research Facility at Eglin AFB, FL. This phase would be completed with a successful demonstration of the scanner to include gathering sample LADAR images of stationary highway vehicle size objects.

POTENTIAL COMMERCIAL MARKET: This project would reduce the size, cost, and complexity of laser radar sensors. Laser radar sensors are used in many commercial applications from photography to machine vision. They provide a unique three dimensional view of the world. Producing a small inexpensive LADAR would open the door to future applications including highway safety and ecology management.

REFERENCES:

L. Beiser and B. J. Thompson, "Selected Papers on Laser Scanning and Recording," SPIE Vol 378 in SPIE Milestone Series, Society of Photo-Optical Instrumentation Engineers, 1985.

AF96-190 TITLE: High Density Shock Survivable Microelectronics

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Conventional Weapons

OBJECTIVE: Develop processes, procedures and components for minimizing the volume of shock hardened electronics.

DESCRIPTION: This effort will investigate the feasibility of utilizing the vertically integrated multichip module (VMCM) or other packaging or circuit element construction techniques for use in shock survivable electronics for impact monitoring recorders and other miniaturized electronics packages requiring additional shock survivability. For example, extensive development of VMCM has been funded both by private industry and government with the goal of significantly increasing electronic packaging densities. These developments have not addressed the mechanical shock environmental requirements required for many applications. The Air Force is heavily engaged in the development of "smart" fuzes for penetrating weapons. These devices contain, as a minimum, an accelerometer, amplifiers and filters, analog to digital converters and microcontrollers or microprocessors. In addition, these devices and other ordnance systems require monitoring, via an on-board data recorders,

of their function during the free flight and terminal environment. The VMCM technique could greatly reduce the volume required for the ever increasing circuit complexity. Any other technique for increasing circuit density in a manner that could survive high shock will be considered. These may include the development of flexible circuit i.e. aluminum item elements or the use of non- brittle materials for multi-chip modules.

PHASE I: Would investigate the available construction techniques with the goal of selecting the best approach to shock survivability. Shock testing of an exiting module will be attempted.

PHASE II: Design, fabricate and test a programmable analog/digital recorder employing the selected technology.

POTENTIAL COMMERCIAL MARKET: Multichip Modules are critical components of recorders for automotive crash testing, aircraft flight recorders, "down hole" mining applications, cellular phones, laptop and palmheld computers, and product shipment monitoring devices.

REFERENCES:
1. "Adopting Multichip - Module Technology"; Electrical Design v. 42 n.13 Jun 27, 1994 p. 153.
2. M. Adadir, A. Parikh, and L. Bal; "Analysis Multichip Module Testing Strategies"; IEEE Design and Test of Computers v. 11 n.1 Spr. 1994 p. 40.
3. A. Flint; "Testing Multichip Modules"; IEEE Spectrum Mar 1, 1994 v. 31 p. 59.

AF96-191 TITLE: Miniature Pulsed Power Generators

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Conventional Weapons

OBJECTIVE: Develop techniques and devices that are capable of producing short duration, large amplitude current and voltage pulses in a small volume.

DESCRIPTION: Present state of the art pulsed power systems used to initiate secondary explosives are capacitor based. Any requirement for more electrical energy results in increases in either the capacitance or a higher operating voltage. Pulsed power systems used to study electrical discharges in plasma physics have used several alternative methods for generating large amplitude current and/or voltage pulses; for example, magnetic flux compression, blumlein, and spiral generators to name a few. New technologies have emerged in recent years that allow for the construction of microminiature devices on hybrid electrical circuits. The purpose of this effort is to explore alternative (non-capacitor based) methods of generating large amplitude current and voltage pulses in very small volumes, or even on a single circuit board. The final device might consist of one or more of the devices mentioned coupled together in a pulse forming network to produce a final output pulse of less than one hundred nanoseconds in duration and amplitudes of 30 to 100 kiloamperes, or 1 to 50 kilovolts depending on the application. The total system should be designed to fill a volume of less than 5 cubic inches.

PHASE I: Phase I of this project would consist of a detailed analysis of the different types of current and voltage pulses needed and some preliminary prototype experiments of the different designs to produce the desired outputs.

PHASE II: Phase II would focus on the development and construction of production quality items of the optimal designs.

POTENTIAL COMMERCIAL MARKET: There are many uses for small, high power electrical circuits. These technology areas include radar, medicine, food, oil drilling, construction, and the automotive industry.

REFERENCES:
1. W. James Sarjeant and R. E. Dollinger, High Power Electronics, Tab Books, 1989.
2. F. Herlach and H. Knoepfel, "Megagauss Fields Generated in Explosive-Driven Flux Compression," Review of Scientific Instruments 36, 1088 (1965).

AF96-192 TITLE: Solid State Accelerometer

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Investigate technologies for a small, survivable three axis accelerometer for sensing low level deceleration in the high shock environments.

DESCRIPTION: Bulk silicon micromachining has been used to fabricate miniature accelerometers for many operating ranges and have been used in hard target fuzing applications. Boron doped diamond thin film acceleration sensing elements have been demonstrated to have a wide dynamic range. The various methods employed for sensing the acceleration are capacitive, piezoresistive, and piezoelectric. The size goal is for the complete three axis device to fit within a volume 0.25 inches by 0.25 inches square (excluding electronics). The sensing range goal is 5 G's to 10,000 G's in each of the three axes and the survivability goal is 100,000 G's with a 0.05 millisecond pulse duration. It is also a goal that the sensor be capable of surviving 8,000 G's with a pulse duration of 10 milliseconds. Our application is for sensing low, moderate, and high deceleration levels in an earth/concrete penetrator. Sensing low level decelerations after surviving a high deceleration impact during penetration is needed.

PHASE I: Investigate sensor technologies and concepts with the potential to meet desired goals. Fabrication of a small batch of devices (single axis) for a selected concept is desired to evaluate survivability through Air Force testing.

PHASE II: Develop and test a three axis sensor based on the concept selected in Phase I.

POTENTIAL COMMERCIAL MARKET: Commercial applications for the devices are for impact sensing, automobile crash sensing, robotics, and industrial manufacturing.

REFERENCES:
1. Design and Fabrication of a Commercial Triaxial Accelerometer, Journal of Applied Sensing Technology, page 22, Aug 94
2. A Rugged High Performance Piezoresistive Accelerometer, Journal of Applied Sensing Technology (Product Feature), Oct91
3. Tradeoffs in Silicon Accelerometer Design, Journal of Applied Sensors Technology, page 24, Aug 94.

AF96-193 TITLE: Low-Cost Compact Ultra-Fast Electromagnetic Sampler

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop and construct a low-cost, ultra-fast electromagnetic sampler

DESCRIPTION: Air Force has an interest in the development of a compact, solid state, inexpensive fast-sampler. The sampler should be able to digitize a transient pulse at a sampling rate of a data per every 5 ps and the data length of at least 1024 points at a time. This sampler should be able to interface with a compact display unit for easy data visualization. The device must be able to interface with a storage device so that the data can be transferred and stored to a hard disk device for later retrieval. The sampler should be as small as possible (less than a cigarette package), and production cost in quantity is hoped to be less than $200.00. Potential shock surviving capability is desired.

PHASE I: Phase I of this program should investigate the technologies available to meet the requirement, design, and construct a breadboard unit. Tests will be performed to confirm that performance meets specifications.

PHASE II: Phase II would involve constructing a brassboard and optimizing performance. Shock surviving test should take place in phase II. The final units may be used as a single unit, or as an array of samplers. In Phase II, improvements in sampling rate to 1 sample/ps will be studied.

POTENTIAL COMMERCIAL MARKET: The fast sampler is an integral part of the short electromagnetic pulse radar and provides a capability of fast sensing and digitization of short EM pulses. This radar device will be utilized in commercial application in sub-surface sensing and detection, geological and environmental exploration.

REFERENCES:
1. Stan Goldman: Understanding the Effects of Phase Noise in ADCs in Sensors, Microwaves and RF, June 1994 issue discusses the effects of sampling-clock phase noise on converter; dynamic range.
2. Frank Goodenough: 12 Bit ADC Runs at 1 Ghz, Puts 20 MA Into 50 Ohm, Electronic Design, Feb 7, 1994.
Technologies relevant to this topic:
High-speed flash analog to digital conversion (ADC) technology. Recent progress made at Lawrence Livermore is noteworthy.
Real-time single-shot translation with cathode ray oscilloscope as done in Tektronix SCD5000.

AF96-194 TITLE: Low Cost, High Power Solid State Switch

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: A 1000-1200 volt switch with a fast turn-on time and low resistance capable of rapid discharge of stored energy.

DESCRIPTION: Our application is to use the devices in firing circuits for high energy detonator firing systems requiring single point initiation of explosives. For many years semiconductor switches have been considered for slapper detonator firing circuit applications due to their low cost. Until recently the detonators required high operating voltages which precluded the consideration of these low cost switches. The recent development of lower voltage, low cost slapper detonators for in-line fuzing has enabled us to reconsider semiconductor switches. Semiconductor switches would reduce the costs of the firing switch as well as the detonator and would result in significantly reduced overall cost for Safe, Arm and Fire (SAF) devices. Metal Oxide Semiconductor (MOS) controlled thyristors with up to a 1000 volt rating are commercially available, however the switch turn-on time is not fast enough for these detonator firing circuits.

PHASE I: Investigate existing switch technologies such as Isolated Gate Bipolar Transistors (IGBT) switch technology, or more far reaching concepts such as light activated polymer switches incorporating photoconductive polymer to achieve fast response time high power switching.

PHASE II: Fabricate semiconductor switches and perform acceptance testing. Develop detailed manufacturing plan and cost data.

POTENTIAL COMMERCIAL MARKET: The commercial application is in the control of switch-mode power supplies used in lasers, radars, televisions.

REFERENCES:
1. 500-V IGBTs Useful in High Voltage Hard Switching Applications, Electronic Design Magazine, Analog Applications Issue, Jun 94.
2. Lock-on Effect in Pulsed-power Semiconductor Switches, Journal of Applied Physics, 15 Mar 92, Volume 71, page 3036.

AF96-195 TITLE: Detection, Analysis and Reuse of Waste Streams Generated by Energetic Materials

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Quality/Civil Engineering
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Technologies to detect, analyze and reuse wastes generated during energetic materials lifecycles.

DESCRIPTION: Explosive and other non-ferrous residues in soils are difficult to detect. Preliminary studies have demonstrated that dielectric constants of contaminant species may allow detection of these contaminants using ground penetrating radar or other methods. Discrimination of various nitrogen-based species in air streams is required for monitoring species generated by thermal treatment of explosive wastes. New instruments/techniques are required to isolate NO, NO2, NO3, N2O, N2O5, NH3 and HNO3. Chemical conversion and catalyzation are techniques to yield economically viable paths for disposing of excess, obsolete munitions and munitions subcomponents are required. Bulk explosive wastes (RDX, HMX, NTO and other CHNO explosives) as well as reclaimed energetic material can be used as raw materials for conversion to commercial grade chemicals. The degradation of energetic materials contained in "dud" buried munitions can be theoretically catalyzed to prevent the unintentional detonation of munitions not recovered after armed conflicts. Previously, trinitrotoluene (TNT) has been converted amino derivatives of toluene, triaminotrinitrobenzene (TATB) and polymers. TNT has also been converted to Tolylene 2, 4-diisocyanate (TDI) and nitrotolyene diisocyanate (NTDI) used to produce urethanes and polyurethane foams. Chelating resins and aerogels have also been derived from TNT.

PHASE I: A literature review and description of existing technologies and methodologies for detecting/analyzing waste streams and contaminated soils will be conducted. Advantages/disadvantages of each will be highlighted and methods of eliminating shortcomings will be identified. Innovative methods to replace these technologies will also be explored. Economically feasible conversion/catalyzation schemes for at least 3 energetic material molecules (other than TNT) will be developed.

PHASE II: The methods identified in Phase I for discriminating contaminants from soils and NOx from other nitrogen

species will be developed and demonstrated. The catalysis/conversion schemes developed in Phase I will be demonstrated in a pilot scale operation.

POTENTIAL COMMERCIAL MARKET: Waste streams generated by munitions mirror those from other industries. Methods of detecting organic contaminants from hazardous material spills and of monitoring NOx in exhaust streams are required for environmentally responsible practices and for compliance with environmental regulations. Excess and obsolete munitions stores along with waste explosives from processing operations could be converted to commercial chemicals for resale.

REFERENCES:
1. "Non-Thermal Plasma Techniques for Pollution Control, Part B: Electron Beam and Electrical Discharge Processing," Edited by B.M. Penetrante et. al. (NATO SI Series G, Ecological Sciences, Vol. 34, Part B. Springer-Verlag), 1992.
2. Mitchell, A. R., "Chemical Conversion of Energetic Materials to Higher Value Products," Proceedings: ADPA Demilitarization Symposium, Meeting #472, Arlington, VA, May 23-25, 1994.

AF96-196 TITLE: Nonlinear Estimators for Transfer Alignment/Navigation

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Conventional Weapons

OBJECTIVE: Develop nonlinear filters using recently discovered techniques and apply to transfer alignment and navigation systems.

DESCRIPTION: Air launched weapon systems need to be able to determine where they are at every instant so they can locate and get to the target. The problem is really two fold. First, the initial conditions need to be established. This is accomplished by transferring information from the aircraft to the missile and estimating inertial measurement unit (IMU) characteristics. The second problem is determining position from sensor measurements, or the navigation problem. The nonlinear estimator developed should be capable of producing superior estimates compared to current estimators during both phases of operation.

PHASE I: Phase I of the program will be to establish the transfer alignment and navigation equations of motion. Development of the nonlinear filters. Non-realtime testing using computer simulations to establish filter effectiveness compared to current filters.

PHASE II: Phase II should be the real time implementation of the filtering equations into a government furnished IMU and dynamic testing of the system to demonstrate performance. The Mobile Inertial Test System will be used for the dynamic tests.

POTENTIAL COMMERCIAL MARKET: Demonstration of the nonlinear filter performance will show that the theoretical filtering technique can be applied to any nonlinear estimation problem.

AF96-197 TITLE: Advanced Techniques for Arena Testing & Image Motion Modeling/Reconstruction

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Conventional Weapons

OBJECTIVE: Technologies to provide fragment velocity/trajectory data and to photometrically reconstruct flight path and attitude.

DESCRIPTION: The objective is to develop and test a technique to remotely measure warhead characteristics, such as fragmentation patterns, fragment size, shape, velocity, and trajectory in an expeditious manner. Presently, weeks of work is involved setting up Styrofoam and wood panels in an arena around the warhead under test. Each panel is carefully placed around the test item and instrumented to measure velocities. After the warhead is detonated each panel is analyzed to determine the number, size, and velocity of all fragments that passed through it. The area is carefully searched for fragments. All fragments discovered are weighed and analyzed. New technology is sought to greatly speed this process by providing fragmentation characteristics data in near real-time, without the labor intensive process in use today. The next objective is to reconstruct the flight path, attitude, and aim point of an instrumented airborne imaging unit based on images of the ground transmitted or recorded from a small aerial sensor. The airborne imaging unit may have high spin rates (on axis), wobble, or

precision. To complicate the problem, the aerial unit will have minimal internal navigation or guidance systems to provide TSPI (Time, Space, and Position Information) data. Since the images will be gathered at video frame rates, the dynamics of the unit must be modeled in order to fill the gaps between successive images. A limited number of GPS (Global Positioning System) surveyed landmarks and DMA (Defense Mapping Agency) mapped areas will be collected per image and used as the ground reference data. The desired technology will be required to process monoscopic images with minimal image overlap. The required outputs of the process will be the trajectory, the aim point along the ground track, and the attitude of the imaging unit projected into a 3-dimensional representation. The target platform for implementation will be a Silicon Graphics Indigo2 Extreme based system running ERDAS, a geographical information system shell to produce an interactive simulation of the flight path and aim point of the imaging unit over a photomosaic ground reconstructed from the gathered images and the reduced data.

PHASE I: Phase I of this project will investigate possible concepts for measuring warhead characteristics such as fragment patterns, velocities, and trajectories in the very harsh environment of an explosion. The second part of Phase I should investigate the different methods to orthorectify, from nonstereo data, the images and "map" them to the ground truth data. This phase should also be able to reconstruct the trajectory of the airborne imaging unit.

PHASE II: Phase II will develop, test, and demonstrate the best concept in an arena environment. It will also design, build, and test a system that can provide precision attitude and aim point data of the airborne imager and interactively simulate the flight path and aim point in 3-dimensions over a photomosaic ground.

POTENTIAL COMMERCIAL MARKET: This project addresses technology that would benefit commercial industry and the military. This technology would aid in performing automobile safety crash tests, studies to reduce damage from terrorist bombs, and in developing explosives techniques for mineral exploration and mining operations. Additionally, this technology would aid in aerial mapping by allowing the use of low cost RPVs (Remotely Piloted Vehicles) with limited internal navigation or guidance systems to be used instead of a more costly airborne platform. This system will reduce the cost of civil engineering mapping techniques that currently require expensive aerial platforms, such as satellites and high flying reconnaissance planes.

REFERENCES:

1. W. G. Hyzer, Photomethods, "Perspective-Grid Parallax Errors," P 6 (April 1989)
2. O. Hadar, S. R. Rotman, N. S. Kopeika, Optical Engineering, "Target Acquisition Modeling of Forward-Motion Considerations for Airborne Reconnaissance Over Hostile Territory," Vol. 33 No. 9, P 3106 (September 1994)
3. G. W. Goodman, Jr., Armed Forces Journal, "Fire and Forget," P 38 (August 1994)

AF96-198 TITLE: Predicting Chemical/Biological Agent Release from Fixed Ground Structures

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Quality/Civil Engineering
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop physics-based models to predict the release of toxic agents from blast-loaded structures.

DESCRIPTION: The presence of civilian populations in close proximity to chemical production facilities and the continued proliferation of chemical and biological weapons (CBW) throughout the world has established a crucial need for the ability to predict the release of CBW agents from structures damaged by natural disasters, accidents, terrorism, or acts of war. A possible solution to this problem is the potential decomposition and/or neutralization of these toxic agents due to incendiary effects or explosively induced combustion reactions. The end product of this effort will provide a useful analytical tool for the safety and structural engineer as well as for the military planner for prediction of CBW agent release, venting, and atmospheric entrainment, as well as any agent decomposition and/or neutralization brought about by combustion of these agents. The development of a simplified physics-based model to describe these phenomena will provide an effective method of assessing the potential environmental effects of attacking WMD targets with existing and future weapons. Current predictive methodologies, with respect to agent release, are semi-empirical in nature and fail to accurately address the agent venting/entrainment problem. Current combustion models are based on liquid petroleum-based products and are focused on determining the target ignition conditions which must be met to achieve sustained combustion. The existing methodologies can not deal with liquid chemical/biological agents and do not allow for the treatment of dry compounds. These methodologies also do not characterize agent volatilization, neutralization or decomposition by- products. This information is needed to establish the toxicity hazard which may result from agent combustion. Within the DOD and the commercial section, neither dynamic agent release nor the by-product results of multiple chemical combustion are well understood.

PHASE I: The Phase I effort will involve exploratory development of a prototype physics-based model suitable for

predicting the release of chemical/biological agents from fixed structures as a result of containment failure due to proximate explosive detonation and subsequent entrainment of these agents in the explosive plume. In addition, the effort will focus on developing a technically sound methodology for compiling a chemical and biological agent property database and predicting their combustion characteristics and decomposition.

PHASE II: The Phase II effort will focus on actually constructing the agent release model and the chemical/biological decomposition database, expanding and validating the model and the database and incorporating them into existing DOD models for assessing target defeat.

POTENTIAL COMMERCIAL MARKET: This predictive methodology has strong commercial potential for industrial and production facilities in which fire safety and emergency evacuation of plant personnel and adjacent civilian populations is of concern due to the flammability of on-site production materials and/or toxic by-products which could be expected to result from their combustion. In addition, the resulting tools would be of commercial value to railroad and trucking companies involved in the transportation of chemical agents to understand which agents are most susceptible to combustion and which agents could be expected to produce hazardous by-products. Commercial fire safety and emergency evacuation officials associated with both of these commercial ventures could utilize these tools to understand the most effective means of handling industrial fires, to design fire protection systems, and to make critical decisions concerning the evacuation of personnel from hazardous areas. This tool could also be used by the Environmental Protection Agency to predict the safety hazard and environmental assault posed by burning chemical and biological agents.

REFERENCES:

1. Baker, W.E., 1973, Explosions in Air, University of Texas Press, Austin, Texas.
2. Dimotakis, P.E., 1991, Turbulent Free Shear Layer Mixing and Combustion, California Institute of Technology, AFOSR-TR-91-0893 (DTIC AD-A243).
3. Henrych, J., 1979, The Dynamics of Explosion and Its Use, Elsevier Publishing, New York, New York.
4. Redondo, J.M., 1986, Effective of Ground Proximity on Dense Gas Entrainment, Journal of Hazardous Materials, Vol. 16, pp. 381-393.
5. Rein, R.G., et al, 1968, The Susceptibility of Potential Target Components to Defeat by Thermal Action, University of Oklahoma Research Institute, Report No. OURI-1578-APR-6.

AF96-199 TITLE: Programmable Multi-Input High Speed Asynchronous Encoder/Decoder

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Develop a programmable multi-input high speed asynchronous encoder/decoder for digital data recording/reproducing.

DESCRIPTION: A technical need exists in the area of interfacing test equipment to recorders and playback systems. The test community continually upgrades instrumentation sensors and recorders as technology progresses. Sensors come with a variety of digital outputs, for example serial or parallel data streams with rates from 0 to hundreds of megabits per second. Digital recorders today record at 240 megabits per second, with tomorrow's recorders, such as the High Speed Solid State Recorder being developed by Wright Laboratory at Eglin AFB, pushing 15 gigabits per second. Millions of dollars are spent interfacing the two technologies. The task at hand is to develop a versatile programmable multiple input asynchronous encoder and decoder. The encoder/decoder should have the following characteristics:

1. Computer programmable input format,
2. 64 bit input in any multiple combinations of serial or parallel data streams,
3. Input data rates (0 to 15 gigabits per second) and time recording durations (0 to 3 hours) both programmable and driven by the users recorder capabilities,
4. Outputs from the decoder capable of reproducing the input data in the format it was received at the encoder,
5. Output data rates compatible with PC rates allowing data transfer directly to hard drive or other storage media.

PHASE I: Investigate the feasibility of producing a Programmable Multi-Input High Speed Asynchronous Encoder/Decoder. Determine the hardware/software and techniques required to develop an item of this type. A preliminary prototype design should be specified and the commercialization and dual use potential should be analyzed.

PHASE II: Design and fabricate a prototype of a Programmable Multi-Input High Speed Asynchronous Encoder/Decoder. Document compliance with specified minimum requirement characteristics.

POTENTIAL COMMERCIAL MARKET: Any industry utilizing monitoring equipment, such as the medical field (Ultra-Sound, EKG, etc.), commercial aerospace, quality control (predictive maintenance), and environmental monitoring.

REFERENCES:
"The Next Generation of Data Recorders", DEFENSE ELECTRONICS, July 1994, page 25.

AF96-200 TITLE: Stick and Peel Adhesive

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials

OBJECTIVE: Develop an adhesive strong enough for aircraft use but with an easy to remove characteristic.

DESCRIPTION: Sub-Miniaturized Telemetry (SMT) and Global Positioning System (GPS) packages are being touted as testing aides for the future. These items, along with their batteries and antenna, will be attached to virtually everything to be tested. GPS will be used for time and position data and the SMT system will be used to transmit this information and other data. Although adhesives exist which are suitable for the attachment of these instruments, they do not permit easy removal. This causes problems with aircraft and other hardware which have to be removed from test scheduling in order to have the adhesive applied or removed.

PHASE I: Determine the properties and/or characteristics needed for this new adhesive.

PHASE II: Design and produce a prototype adhesive and all necessary requirements documents. The adhesive will then be tested on actual aircraft flight tests.

POTENTIAL COMMERCIAL MARKET: In any test environment where an adhesive is needed. Since the aircraft environment includes temperature changes, temperature extremes, vibration, etc., the resulting product should have a wide range of applicability.

AF96-201 TITLE: Calibrated Infrared (IR) Focal Plane Array (FPA) Imagers

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop calibrated FPAs capable of absolute measurements in both the MiddleWave IR (MWIR) and LongWave IR (LWIR) regions.

DESCRIPTION: As smart weapons advance to super smart or intelligent weapons so must the technologies to evaluate the weapon systems. Today's weapon systems, such as LANTIRN (LWIR) and ASRAAM (MWIR) are using Focal Plane Array (FPA) technologies. The capabilities and limitations of these and other systems must be tested. The IR measurement test community today calibrates single element or sprite scanning imagers with typical Instantaneous Fields Of View (IFOV) of 0.7 milliradian. Current weapon FPA imagers have typical IFOVs of 0.1 milliradian. Data measured at a slant range of 5000 feet produces a pixel size of 0.5 feet by 0.5 feet with the items under test, while the measurements instrumentation yields a pixel size of 3.5 feet by 3.5 feet. The measurement data in no way reflects the fidelity and capability of the weapon under test. Given these facts, measurement instrumentation must be developed that meets or exceeds the capabilities of the weapons under test. The task is to develop calibratable LongWave and MiddleWave IR imaging FPA systems capable of absolute infrared measurements. Basic requirements for a LongWave (8-12 micrometers) and MiddleWave (3-5 micrometers) imager meeting this need are:

1. 0.1 milliradian IFOV or better with a 5 X 5 degree FOV,
2. Ruggedized for airborne use,
3. RS-170 and digital data output,
4. Dynamic range from -20 degrees C to 1500 degrees C.

PHASE I: Investigate the feasibility of producing LongWave and MiddleWave IR calibratable absolute measurement FPA imagers. Determine the hardware/software and technics required to develop imagers of this type. Generate preliminary design specifications and investigate the potential for commercialization and dual use potential.

PHASE II: Design and fabricate a prototype of a LongWave and/or MiddleWave FPA imager. Define the calibration

procedures and technics for absolute target measurement. Document applicable test data demonstrating compliance with the system requirements.

POTENTIAL COMMERCIAL MARKET: IR imagers are widely used in the medical field of diagnostics, by industry for quality control (predictive maintenance), and environmental compliance monitoring.

REFERENCES:
"Better, Smaller IR Imagers Lead the Way to New Applications", PHOTONICS SPECTRA, December 1994.

AF96-202 TITLE: Arena Test Fragment Field Evaluator

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Munitions Devices & Energetic Systems

OBJECTIVE: Develop a capability to determine the vector field data from an exploding warhead test.

DESCRIPTION: Warhead arena tests are conducted to determine the spray pattern of the warhead fragments resulting from the detonation of the warhead. To determine the lethality of these fragments, both the weight and velocity of the fragments must be known. Currently, collection technologies and methods result in fragment velocity data and fragment weight data, but these data are generally not tied together. Although a fragment weight and location is known, only a range of possible velocity values can be assigned to it. The fragment velocity is recorded by use of switch screens placed on the front of bundles which stop and catch the fragments. Each bundle will have several fragments in it and each switch screen will take several hits. Thus, an association problem occurs.

PHASE I: Determine the hardware/software requirements to accomplish this objective.

PHASE II: Design, develop, and produce a prototype system and integrate the software. Validate the system during actual test events under benign test conditions and document the results.

POTENTIAL COMMERCIAL MARKET: Industries using explosive devices: oil and mining industries, road and building construction, safety avalanche control (resort industry).

REFERENCES:
ADTC-TR-72-127, "Vulnerability and Lethality Testing System (VALTS)", December 1971, DTIC Accession Number AD090149L.

AF96-203 TITLE: Water Impact Scoring

CATEGORY: Basic Research
DOD TECHNOLOGIES: Marine Systems

OBJECTIVE: Develop an ability to determine the impact point of a munition entering the water (Gulf of Mexico) to within one foot accuracy.

DESCRIPTION: With the advent of GPS and related technologies, a system could be developed that uses buoys or other nonfixed structures which would enable the scoring of the impact of a noncooperative (no interactive position feedback) munition in the Gulf to within one foot accuracy.

PHASE I: Determine the hardware/software requirements to accomplish this objective.

PHASE II: Design, develop, and produce a prototype system and integrate the software. Validate the system during actual test events under benign test conditions and document the results.

POTENTIAL COMMERCIAL MARKET: The resulting devices should be able to provide positions of any item in water. The subject will probably have to be in motion (making some sense of noise). Possible use would include: -Tracking boats in a harbor (including identifying those speeding) -Tracking large fish or mammals (whales, manatees, etc.) -Tracking egress into a closed area, fishing boats in closed area, drug running.

AF96-204 TITLE: <u>Multiple Direction Blast Pressure Measurement</u>

CATEGORY: Basic Research
DOD TECHNOLOGIES: Munitions Devices & Energetic Systems

OBJECTIVE: Develop a capability to measure true blast wave data and analyze existing airblast codes and assist in developing updated codes that will operate on a desktop computer.

DESCRIPTION: Blast wave data (pressure-time trace) are obtained during a number of different types of explosive event characterization tests. Pressure gauges suffer from two basic problems: response time and direction. Since the explosive items being tested are not generally spherical and center initiated, the precise wave shape is generally not known. This presents a problem for the gauge positioning.

PHASE I: Define the hardware/software necessary to accomplish the task of determining the true blast pressure-time trace (even with some uncertainty of wave vector).

PHASE II: Design, develop, and produce a prototype system and integrate software. Validate the system during actual test events under benign test conditions and document the results.

POTENTIAL COMMERCIAL MARKET: Industries using explosive devices: oil and mining industries, road and building construction, safety/avalanche control (resort industry).

AF96-205 TITLE: <u>Ultrasound for circuit card diagnostics</u>

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop method to test the integrity of circuit cards and solder joints.

DESCRIPTION: Our goal is to create a method by which a circuit card can be evaluated using ultrasonic probing or imaging to quickly identify physical faults on the card, i.e. delaminations, bad solder joints, broken leads and traces, which can cause system failures, including intermittent failures that tie up repair resources. The desired output of this SBIR is a product that can provide this type of information back to the technician, with enough "intelligence" that it can identify problems automatically. Problem identification should be generalized, meaning that the system should not be "trained" to identify faults on a specific card, but be able to detect similar faults on a broad range of cards.

PHASE I: Contractor will explore potential method(s) for diagnosing physical faults on circuit cards using ultrasonic means. Preference for approaches using commercial off-the-shelf components. Solution should be portable, and easy to use. Preliminary concept validation must be performed.

PHASE II: (1) Generate a working model of the ultrasound diagnostic system. (2) Obtain representative circuit cards, induce faults and evaluate the ability of the system to detect, recognize and generalize on the differences in the cards. (3) The contractor will generate the documentation and software necessary to create a user friendly system for Air Force personnel to train the system on new circuit cards and/or different faults. (4) Contractor will generate a report of the effectiveness of this technology, how it can be implemented and potential improvements.

POTENTIAL COMMERCIAL MARKET: This technology will have applicability to all forms of circuit card testing, both commercial and within the DOD. All circuit card manufacturers use quality control testing prior to card shipment, and major electronics firms possess in house diagnostics and repair capability. The ability to find physical causes of circuit card failures quickly would remove many causes of the "retest OK" problem, where faulty cards fail in the field but appear good in the benign depot environment.

REFERENCES:
Allemang, Richard J., Brown, David L., Experimental Modal Analysis, Shock & Vibration Handbook, 1987, p 21-1 - 21-34

AF96-206 TITLE: Filmless Radiography

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop digitally archive images rather than storing them on film.

DESCRIPTION: The Air Force uses stock class 6635 radiographic film to perform non-destructive inspection. According to the Defense General Supply Center, Richmond VA, 618,782 requisitions for film were submitted last year by the Air Force costing $439.4M. The unexposed film must be refrigerated prior to use and exposed film must be documented and maintained for reference. This is a burdensome, inefficient, and expensive activity, requiring filing of hundreds of thousands of films. If the Air force could convert to filmless images stored electronically it is estimated that over $400M in supply, storage, and admin costs would be saved. In addition film processing chemicals involve hazardous materials and require correct environmental procedure. The basic technology exists but is currently cost prohibitive and not developed for many types of inspections, e.g. curved surfaces.

PHASE I: Perform feasibility study for development of digital image storing, large-scale production, special adaptations, and economic justification.

PHASE II: Generate final working (prototype) model of filmless radiography production system. Set up system at a depot demonstrating effectiveness. Provide complete documentation and reporting on successes/failures.

POTENTIAL COMMERCIAL MARKET: This filmless radiography system would have broad application in defense, government, and industry.

REFERENCES:
Miyahara, Junji, "Visualizing Things Never Before Seen: The Imaging Plate - A new radioaction image sensor," Chemistry Today, Oct 1989, pp. 29-36.

AF96-207 TITLE: Repair tracking system

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop a means of tracking failure data on circuit cards.

DESCRIPTION: There is currently no universally applied method of tracking the circuit card repair process within the Air Force. A need exists for the generation of a circuit card repair tracking system that can maintain repair records for individual circuit cards in a highly automated fashion. This entails the ability to scan in cards upon receipt through an identification system, which recognizes individual circuit cards through a permanent identifying mark or component on the card. The identifier can not interfere with the form, fit or function of the cards, and must be immune to the majority of repair processes used by the Air Force. This would improve the technical support response time, technical expertise retention in repair and identify bad actors for product improvement.

Software developed for this system should be based on a commercially standard software development environment to ensure ease of maintenance and upgrades. Primary criteria (outside of basic tracking functions) are ease of use, intuitive interface, and ease of implementation (no new computer systems, simple to integrate). Graphical representations of high failure components, circuit diagrams, "alarms" for repeated failure modes, and ease of updating with repair data would greatly help. The system should be accessible by multiple users over a LAN. Use of existing commercial or government applications as components of the proposed solution a strong plus.

PHASE I: Contractor will define the components and capabilities of the tracking system, coordinating the system definition with Air Force depot personnel. A basic working model for the final system will be generated, to provide a demonstration of how the final system will operate.

PHASE II: (1) Generate the final working model (prototype) of the tracking system. (2) Integrate the system at a working depot, providing system support and problem resolution over 1 year. (3) Contractor will generate a report of the effectiveness of this system, how it can be implemented at other locations and potential improvements (Internet interconnection, etc). It is hoped that at the conclusion of Phase II the system can be marketed by the small business for support of other DOD

maintenance systems.

POTENTIAL COMMERCIAL MARKET: This repair tracking system would have broad applicability at all service depots, and would be usable within industry for tracking product maintenance.

REFERENCES:
IEEE P1389 - Standard for the Evaluation of Test and Maintenance Information, POC Dan Weiss, E-Mail: danielweiss@delphi.com, (703)764-3271

AF96-208 TITLE: High Strength Aircraft Quality Bolts Manufactured From Smart Materials

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop "smart" bolts that will not require conventional NDI to find defects

DESCRIPTION: There are many high strength steel bolts (180-220 ski) installed on the C-130 aircraft which require period removal for nondestructive inspection (NDI). These bolts are primarily used in the center-to-outer wing attachment, engine truss mount to quick engine change (QED) module, and in various fuselage attachment fittings throughout the aircraft. There are two primary reasons why the elimination of the conventional NDI of these bolts would be beneficial. The first reason is the lack of accessibility of the bolts. To gain assess to the bolts sometimes requires the removal of adjoining structure or the jacking and shoring of the wings or fuselage. The second reason is to eliminate the damage caused by the removal and replacement of the bolts for inspection. If the components that the bolts are in, are not no-loaded sufficiently, the removal of the bolts can cause thread marks or scratches to be left on the component, resulting in crack initiation points which will reduce the service life. This task will require the contractor to develop a high strength bolt, using smart materials, that will eliminate the need for periodic inspections using conventional NDI procedures. Conventional NDI procedures are defined as magnetic particle, ultrasonic, eddy current, and X-ray inspections which require the bolt to be removed from the aircraft. The bolts most commonly used for this application are Ms 21250 series bolts. The ultimate goal of this effort is to develop a bolt that can be reliably and easily inspected without being removed and that can be manufactured using current bolt manufacturing technology.

PHASE I: This part of the effort should identify a high strength smart material that meets the criteria for strength, inspectibility, and manufacturability and produce a bolt design that is compatible with the existing MS 21250 specification.

PHASE II: This part of the effort will require the contractor to produce several prototype bolts which will be both nondestructively and destructively tested and analyzed and be subject to a form, fit, and function verification. The bolt design will be finalized and a level III drawing package will be delivered. Any special equipment required for the inspection of the bolts will be identified along with inspection procedures and illustrated parts breakdown data for incorporation into USAF technical orders and job guides.

POTENTIAL COMMERCIAL MARKET: There are many high strength bolt applications in industrial machinery, ships, and bridges that would benefit from this technology.

AF96-209 TITLE: Early Warning Aircraft Damage Detection

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop an easy-to-use, nonintrusive tool to detect areas of damage in aerospace vehicles.

DESCRIPTION: Current detection techniques such as ultrasonic's and x-ray technology are very good at determining damage to an airframe once the general location of the damage is known. Unfortunately, because of the high cost of x-ray and ultrasonic scanning for an entire airplane, large sections of the airframe can be left unchecked. A tool is needed that can quickly and cost effectively find the relative position of damage so that x-ray and ultrasonic techniques can be better used. With the improvements in sensors and lasers, this tool requirement could be met using laser velocimetry or laser imaging combined with an intelligent system to detect deviations from expected mechanical behavior. The proposed system should show how it is significantly more cost effective over present techniques and should require only limited training for a technician to use.

PHASE I: Phase I of the proposal will outline a test play for demonstrating the technology on a small structure.
PHASE II: Phase II will examine how the system will cover an entire airplane and develop a prototype system.

POTENTIAL COMMERCIAL MARKET: When this technology is successfully developed there would be obvious applications for aging aircraft in the military as well as commercial fleet. Such a technology might also be used to quickly inspect surface vehicles such as buses and trains.

AF96-210 TITLE: Tomographic Image Analysis Software

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Software

OBJECTIVE: Develop an Image Analysis system to analyze Computer Aided Tomography (CAT) images.

DESCRIPTION: Computer Aided Tomography is used to aid in the detection of hydrogen contamination of titanium alloy materials such as jet engine fan blades. If hydrogen is present in the fan blade, it can cause blade failure resulting in severe damage to the engine and airplane. Two aircraft have been lost due to this problem. There are two distinct phases of the analysis process. The first phase is the image capture and tomographic reconstruction of the object under test. This phase is automated and requires very little operator intervention. The second phase is the analysis of the reconstructed images for hydrogen contamination. This phase is done manually and takes up to a day per set of images to complete. The current manual image analysis process is not cost effective in a production environment due to its low throughput rate.

The purpose of this project is to perform a feasibility study and develop innovative image analysis software capable of performing automatic analysis of tomographic images with little or no operator intervention. Automation of the analysis process would greatly increase the throughput of objects being tested making the system cost effective for full production use.

PHASE I: Perform a feasibility study and develop a prototype image analysis program capable of: (1) detecting up to three fan blades per image set (2) sampling blade and background image data and (3) calculating hydrogen contamination levels from sampled data.

PHASE II: Demonstrate an automated analysis production rate of three blade image sets per hour.

POTENTIAL COMMERCIAL MARKET: Automatic image analysis techniques for this project have application to military/commercial aviation and medical applications. Automated image analysis of aircraft parts and medical imaging can benefit greatly from the increased accuracy and decreased diagnostic time of an automated analysis system.

AF96-211 TITLE: Prediction of Remaining Useful Life of Aircraft Components Using Non-Destructive Inspection (NDI) Data

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop algorithms, using correlated data from NDI systems, to determine remaining useful life of inspected components.

DESCRIPTION: Current NDI technology determines flaws in aircraft components made of composite materials. Flawed parts are usually replaced or repaired without ascertaining the significance of the flaw. The aircraft is not available for service during the repairs. Guidelines have been developed to determine when a flaw is too small to repair on an individual flaw basis without added analysis. There is a need for guidelines in cases when multiple small flaws are assessed together or other unique flaw characteristics dramatically change the actual significance of the flaw on the part's remaining useful life. Numerous technical problems must be resolved to make this commercially viable. The strength characteristics model of the component must be developed in a simple and accurate method. The possible failure modes and the mathematics of these failures must be related to the strength model. The NDI data from the various systems must be particularized to one another and converted to a mathematical form that can be, in turn, referenced back to the strength characteristic model of the part. The results of this modeling process will be a detailed characteristics model of the component that includes strength characteristics and an estimate of the remaining useful service life of the component. Using McClellan's Laser Ultrasonic Inspection System (LUIS),

N-ray-X-ray, and Ultrasonic System with the Silicon Graphics, Inc. (SGI) computer system, overlay all of the flaw data from various systems. This data is to be automatically analyzed and compared to the structural data of the component. For comparison, a remaining strength before failure model is developed which will include failure model and fail time under various load conditions. The proposed component for this demonstration is the Marine Corps Harrier Jump Jet Wing.

PHASE I: Determine if it is possible to achieve the objective using McClellan's NDI Equipment and in-house SGI Systems.

PHASE II: Develop algorithms to determine the impact of imperfections found using NDI data gathered with McClellan's NDI equipment. Build the algorithms for the Marine Corp's Harrier Jump Jet Wing.

POTENTIAL COMMERCIAL MARKET: The ability to predict failure time in aircraft components based upon NDI data is of great monetary value to the airline industry as well as the military aircraft. The ability to scan an intact aircraft, facilitate component removal, and evaluate/produce structurally safe aircraft/components is of priceless benefit to aircraft industry and aircraft occupants.

REFERENCES:
1. Williams, J.J., Jr. and Lee, S.S., "Promising Quantitative NDE Techniques for Composite Materials," Materials Evaluation, Vol. 43, No. 5, April 1985, pgs. 561-565.
2. Scruby, D.B. and Drain, L.E., Laser Ultrasonics: Techniques and Applications, Adam Hilger, NY, NY, 1990.

AF96-212 TITLE: Improved Flush Fastener Technology

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop a cost effective countersunk fastener having installed tolerances of less than +/- 0.001".

DESCRIPTION: Current high performance aircraft rely on the attainment of aerodynamically smooth exterior surfaces to reduce parasitic drag, reduce fuel consumption and in the case of Low Observable (LO) aircraft, assist in the reduction of high frequency Radar Cross-Section (RCS) signatures. State-of-the-art in flush fastener and flush fastener installation technology requires automation or hand crafting by skilled manufacturing technicians to achieve installed tolerances nominally within +/-0.0005" of the surface. On an aircraft production line, added expense is incurred to purchasing close tolerance fasteners to facilitate fewer manhours to achieve the desired tolerances. In the case of a close tolerance fastener, close tolerance refers to the distance from the bottom of the countersink to the top of the fastener. This entails a 100% inspection at the fastener manufacturer's plant that, in turn, increases the cost of the fasteners. Once installed in the aircraft, a quality assurance function must follow the installation to check the installed tolerance. If installed high, nonconforming parts are either shaved to tolerance or removed and another fastener installed that conforms to the specification. This is a particular problem with steel and titanium fasteners as they do not lend themselves to easy grinding or shaving. If installed too low, either an aerodynamic filler may be used to fill the low fastener or the fastener may be replaced. These installation processes and controls are personnel intensive and expensive. A new approach would examine current fastener and installation technology and develop a technique capable of repeatedly installing flush fasteners in aircraft structure nominally flush to within +/-0.001" of the surface in metal and the various types of composite structure found in aircraft production.

PHASE I: Evaluate current fastener and fastener installation technology. Collect data to determine commercially available fastener installation rates and installation tolerances. Evaluate potential fastener technology enhancements and propose practical solutions. Perform predictions to quantify potential benefits of flush design in terms of fastener installation cost reductions, aerodynamic drag reduction, or potential RCS reduction. Perform preliminary product design

PHASE II: Prototype preliminary design and the manufacturing process to economically produce the flush fastener system. Demonstrate the fastener can be installed in prepared test panels flush to +/-0.001 inch in less than 30 seconds per fastener when measured with 100 fasteners. Develop fastener installation verification techniques. Perform mechanical testing to characterize the performance of the new concept. Demonstrate the ability to economically produce the fasteners in quantity.

POTENTIAL COMMERCIAL MARKET: This technology has tremendous commercial and military potential. Reducing aerodynamic drag reduces fuel consumption and improves the potential top speed of aircraft. Cosmetic benefits to commercial aircraft manufacturers include the inability of airline passengers to discern installed fasteners. On LO military aircraft, the smoother, more electrically continuous surface reduces the RCS signature of the aircraft.

AF96-213 TITLE: Fractal Applications for Simulation Environments

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Software

OBJECTIVE: Develop a system for fractal video technology insertions for real-time simulation systems.

DESCRIPTION: The increasing reliance of military systems on digital imagery creates several challenges. The first is the massive amount of data generated by imagery. This affects both the transmission of critical data over communication lines of varying bandwidths, and storage. The second challenge is the integrity of the image data itself. It would be a serious defense problem for any compression scheme that introduces artifacts or eliminates marginal data that may be critical to the original source image, be it surveillance photo, target acquisition data, or satellite imagery. The fractal compression technology and fractal mathematics associated with this project is established. Fractal compression provides a method of representing digital image data as mathematical formulae. This provides high fidelity to the original image while offering the highest compression ratios. Execution of the formulae or equations provides restoration of the original image or video with near perfect quality. The intent is to develop a system capable of parallel processing (compression and display) digital imagery data for insertion into real-time simulation systems.

PHASE I: Conduct a feasibility study/analysis to determine the requirements of a system capable of selecting "target areas" within any given image, and then extracting the fractal mathematical formulae that describes the selected target. Included will be domain analysis of fractal formulae/equations, fractal objects, and fractal objects database. An economic analysis will also be required of the cost to produce the system, operating costs, and return on investment. A detailed analysis and preliminary design of the video technology insertion system shall be provided.

PHASE II: In this tasking, a prototype of the video technology insertion system shall be developed/delivered. The prototype shall be capable of demonstrating image acquisition; fractal domain analysis/identification; creation of a fractal object database; and application that uses a limited database library of fractal objects in a simulation system.

POTENTIAL COMMERCIAL MARKET: Fractal compression applies anywhere where still and/or video pictures are desired in a digital environment. If fractal compression can be applied to simulator environments, it has the potential to reach markets in the aviation, aerospace, automobile, gaming, entertainment, and emerging virtual reality industries.

REFERENCES:
Tech Literature: 'New Media' March 1994 article "Crunch Time for Digital Video"; Research: "Multi-Media Technology Developments" - G.D. Gaugler, Sept 1993

AF96-214 TITLE: Low Cost Curing and Repair Process for Composites

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Materials, Processes and Structures

OBJECTIVE: Develop control technology to manage composite material quality and environmental impact.

DESCRIPTION: Current composite material processing systems use thermocouples as the basic sensor for process evaluation. There are also dielectric, ultrasonic, and other sensor systems available for use. Of interest is the development of control technology which uses a single sensor capable of determining other parameters such as temperature, pressure, viscosity of the material and cure chemistry.

Advanced, multiple sensor technology has been demonstrated in previous work to reduce process time and therefore reduce costs. A logical extension of this work is to produce a single sensor system that provides multiple parameters. Also, the need exists for the development of cure and thermal models which would be validated by the single sensor data, then used to control a computerized processing system. The system would use these models for reduction of process time and cost, while minimizing environmental pollution. The goal is direct control of the process, based on material state rather than time and temperature.

PHASE I: Investigate the feasibility and payoff advantages of the technology through a feasibility study. A network capability between remote units and depot systems would also be investigated.

PHASE II: Complete validation of a prototype system with an advanced laboratory prototype. Investigate the feasibility of using this technology to produce field repair units.

POTENTIAL COMMERCIAL MARKET: Composites are in widespread application in the aerospace industry and other industries. A system of this type could be used with many existing control systems with little or no hardware changes. Many private aerospace companies and government repair depots would be potential users of this system.

AF96-215 TITLE: Portable Large Area Rapid Scan Nondestructive Inspection (NDI) for Composite Components

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop equipment for rapid detection of defects in complexly shaped aircraft components.

DESCRIPTION: The down side of the side spread use of composite materials as structural members on aircraft is that primary aircraft structure cannot economically be removed from the aircraft and taken to a facility for inspection. Primary aircraft structure must be inspected on the aircraft. Current on-aircraft composite inspections are very labor intensive. Detection of defects in composite materials differs from detection of defects in standard metallic aircraft materials. The current need is for a portable, user friendly inspection system that can scan large areas of complex contoured composite materials very quickly and locate all detrimental material conditions. (AFMC Technology master Process Technology Need Number 95A0151).

PHASE I: Research to determine which method would allow the best combination of scan rate, sensitivity, and accuracy for the inspection of composite materials. further research on the basic problem of location of defects. End item for Phase I would be preliminary drawings and requirements.

PHASE II: The development, fabrication, and prototype of the inspection equipment. End item for Phase II would be the design enhancement, drawing revision for manufacture, test and validation of the inspection equipment for use on the production shop floor.

POTENTIAL COMMERCIAL MARKET: Direct transfer to the private aircraft sector and for sale to foreign military entities.

REFERENCES:
1. The January 1988 Report of NONDESTRUCTIVE EVALUATION OF LARGE SCALE COMPOSITE COMPONENTS, AFWAL-TR-87-4116, for the development of a reciprocating time-of-flight ultrasonic inspection system capable of rapid scanning on Large Area Composite Structures (LACS-M).
2. The October 1988 Report of COMPOSITE INSERVICE INSPECTION SYSTEM PRODUCIBILITY, AFWAL-TR-88-4218, for the development, fabrication, and delivery of an Automated Real-Time Imaging System (ARIS).

AF96-216 TITLE: Thermal Fuel Tank Leak Detection Device

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop an improved method of finding fuel tank leaks.

DESCRIPTION: Several methods are available to aid fuel mechanics in detecting fuel leaks including: Vacuum/pressure soap bubble, ammonia and dye, fuel dye, and ultrasound. Due to limited visibility from obstructions, it is very difficult to see leak detection fluid and to pinpoint the source of an audible signal from an ultrasonic detection device. To aid in the identification of fuel tank leaks, the fuel tank could be pressurized with warm air that could be visualized by a fuel worker aided with a thermal visualization device. (AFMC Technology Master Process Technology Need Number 95A0155).

PHASE I: Research possible infrared or other type "visors" that may be able to visualize the flow of warm air. Investigate the feasibility on the basis of portability, cost, resolution, reliability, and ease of use. The device when worn by the mechanic, should enable the mechanic to easily locate the flow of warm air from a fuel tank leak location. The end item would be a feasibility assessment of a laboratory device that would demonstrate this detection capability.

PHASE II: Develop a prototype that can be used by a fuel mechanic in a production environment.

POTENTIAL COMMERCIAL MARKET: Fuel leak detection is needed for all commercial and DOD aviation maintenance. The device may also be suitable for leak detection in other pressurized systems such as oxygen systems, pressure vessels, etc.

AF96-217 TITLE: Low Cost, Calibrated, Portable, computer Controlled Variable Output IR/UV Source

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Design and develop a low cost, calibrated, portable, computer controlled variable output IR/UV source for testing IR/UV sensors.

DESCRIPTION: The ability to stimulate IR/UV sensors installed on aircraft in an RF anechoic test chamber is required to conduct system level sensor/avionics checkout. Part of the tests requires the placement of several/many small (non-RFI intrusive), calibrated, portable, computer controlled variable output IR/UV sources. These sources shall be capable of emulating the IR/UV signature of unresolved aircraft (IR only) in flight, missiles (IR & UV), ground targets, flares and other countermeasures (if possible). The source signatures could be placed at a distance as close as a few feet to several hundred feet from the IR sensor under test. The sources will simulate apparent IR/UV targets which would be at a distance of several km or more. The test sequence of one to many sources shall be under computer control with the capability to separately varying the initiation/ending times and time dependent spectral characteristics of each source.

PHASE I: Should result in a technical feasibility analysis and proposed system design.

PHASE II: Build and demonstrate a system in the Benefield Anechoic Chamber at Edwards AFB, CA.

POTENTIAL COMMERCIAL MARKET: Proper testing of the growing numbers of FLIR equipped civilian and military aircraft requires calibrated IR sources. A derivative of the portable, computer controlled and calibrated IR source would be an excellent candidate FLIR tester since tests could be conducted without removal of the FLIR sensor to a laboratory condition.

AF96-218 TITLE: Airborne Data Recorder

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Develop a low cost, compact, mid-rate data recorder for airborne flight test use

DESCRIPTION: Open air flight test involves data collection from on-vehicle sensors and data buses at ever increasing rates. Current data acquisition systems are capable of producing up to 60 Mb/s in multiple Pulse Code Modulation (PCM) streams. We need a method to capture this data onboard for up to 2 hours, packaged in a very small volume, and capable of surviving the uncontrolled environment of flight in a tactical fighter aircraft. Cost to purchase and operate the device must be very low.

PHASE I: Should result in a technical feasibility analysis and a proposed design

PHASE II: Should result in a demonstration of a prototype system representing a near final design. While the demonstration need not be in an airborne environment, the more realistic the conditions the better.

POTENTIAL COMMERCIAL MARKET: We believe that there is a market for multiple future applications in such markets as automatic design and test and civil aviation.

AF96-219 TITLE: Avionics Bus Data Compression

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop data compression technologies to reduce bandwidth required for telemetering digital avionics bus data.

DESCRIPTION: This requirement is to develop a data compression capability that greatly reduced the bandwidth required for telemetering avionics bus data. Modern aircraft avionics and data acquisition systems incorporate increasing numbers of digital devices which are interconnected with high speed buses. The data transferred on these buses are critical to the performance of the aircraft and must be monitored during any test program. As the numbers and transmission rates of these devices increases, the bandwidth required for telemetering increases. However, most test-critical data are not generated continuously, but in bursts which occur during in-flight event, much of the data generated are either redundant or irrelevant to the results of the test

program. The intent of this research is to propose a method to reduce the bandwidth requirement for there data. The research should determine the characteristics of the data that may be used for discrimination. It should also attempt to apply standard data compression methods or extensions thereof in accomplishing this purpose. The goal of this effort is to reduce telemetry bandwidth requirements by a factor of 2 or 4. Proposed solutions must address the need to minimize latency in telemetry streams.

PHASE I: Conduct a feasibility analysis and prepare a recommended system design.

PHASE II: Construct a prototype system and demonstrate at the Air Force Flight Test Center (AFFTC)

POTENTIAL COMMERCIAL MARKET: This technique is directly applicable to test of commercial aircraft, and by extension other vehicles such as automobiles.

REFERENCES:

1. MIL-STD-1553, Aircraft Internal Time Division Command/Response Multiplex Data Bus
2. MIL-HBK-1553, Multiplex Application Handbook

AF96-220 TITLE: Optimal Utilization of Telemetry Spectrum

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Telecommunications

OBJECTIVE: Develop advanced communications technologies to address the problem of under-utilization of the telemetry frequency spectrum.

DESCRIPTION: This requirement is to develop a demand assignment multiple access scheduling capability to greatly increase utilization of the telemetry frequency spectrum. The current method of managing the radio frequency (RF) bands reserved for government aeronautical telemetry (i.e.1435-1535, 2200-2290 and 2310-2390 MHz) is becoming increasingly less capable of satisfying user requirements. The DoD frequency management community currently uses frequency division multiple access (FDMA) to partition telemetry bands so they can be shared among multiple users. The current method used to assign FDMA channels among multiple users is to dedicate a channel to a single user for the duration of this test phase. This method can be characterized as fixed assignment multiple access scheduling. The growing demand for wideband telemetry among aircraft test programs, and loss of spectrum through legislation are beginning to strain the existing access and scheduling methods. Deficiencies with the current methods include low utilization of spectrum, lack of flexibility in satisfying fluctuating demand, limited commonality among user equipment, and limited opportunity for test aircraft to be interoperable across ranges. Perhaps it is time to search for innovative solutions to the problem of managing the telemetry spectrum. Proposed solutions might consider more efficient encoding and modulation schemes, or ways to improve the efficiency of FDMA (perhaps by better filtering and narrower inter-channel bands). Solutions might consider more efficient encoding and modulation schemes, or ways to improve the efficiency of FDMA (perhaps by better filtering and narrower inter-channel bands). Solutions might consider combinations of access methods, such as frequency/time/code division multiple access (F/T/CDMA). Solutions might consider variable rate PCM combiners and digital premodulation filters, as well as the use of tunable airborne transmitters and antennas capable of operation over a wide range of frequencies. Solutions should also look for more efficient ways to schedule telemetry channels. Demand assignment multiple access (DAMA) scheduling could greatly increase utilization of the spectrum and provide the needed flexibility to satisfy fluctuating user demands. Solutions should look at a layered approach to DAMA scheduling that includes a core capability as well as enhancements, such as the use of a common air data link to remotely monitor and control critical airborne elements of the end-to-end telemetering process.

PHASE I: Conduct a feasibility analysis and prepare a recommended system design.

PHASE II: Construct a prototype system and demonstrate at the Air Force Flight test Center (AFFTC)

POTENTIAL COMMERCIAL MARKET: This technique is directly applicable to test of commercial aircraft, and by extension other vehicle such as automobiles.

REFERENCES:

IRIG Standard 106-93, Telemetry Standards

AF96-221 TITLE: Universal Programmable (Computer to IR Sensor) Interface - UPI

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Develop a universal programmable interface to translate in real-time computer generated IR/EO imagery into signal levels and formats compatible for direct signal injection into the post-detector electronics of IR/EO sensors on board military aircraft.

DESCRIPTION: Laboratory stimulation of IR/EO sensors can be achieved by the projection of an IR/EO scene photonically, or by the direct injection of a signal representing an IR/EO scene into the IR/EO sensor signal processing electronics. To interface properly with the signal processing electronics, the user must be certain that the computer generated imagery signal is properly translated into the correct gain, offset voltage, or format (ex. video) needed to achieve an accurate rendition of the IR/EO imagery for the sensor under test. It is desirable to develop a single universal programmable interface (UPI) unit rather than build a separate translator for every IR/EO sensor. The classes of IR sensors include IRSTs, FLIRs, MLD (missile launch detection/MAW (missile approach warning), and IRMS (IR missile seekers, both imaging and nonimaging). Frame rates can vary from about 1 Hz to 150 Hz. Frame size (H x V pixels) will vary and can be as large as 1024 x 1024. The contractor shall conduct a feasibility study to determine if a single UPI unit can achieve the stated goals, and if feasible, develop a preliminary design. The contractor should have sufficient knowledge and experience with IR/EO sensors and their associated signal processing electronics to assist in defining direct signal injection electrical signal parameters and standards for the UPI.

PHASE I: Should result in a technical feasibility analysis and proposed system design and cost analysis for the Universal Programmable Interface unit.

PHASE II: Build and test Universal Programmable Interface unit for IR/EO sensors.

POTENTIAL COMMERCIAL MARKET: Computer generated IR/EO imagery can be used to test and debug IR/EO sensors/signal processing electronics. A UPI would facilitate tests of the signal processing electronics apart from the actual optics/detectors under controlled laboratory conditions with computer generated scenarios, targets and backgrounds. It could be part of a manufacturing test and quality control of IR/EO sensor systems.

AF96-222 TITLE: Automated Anechoic Chamber Electromagnetic Field Probe

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop an automatic electromagnetic field probe to measure the electromagnetic fields in an anechoic chamber.

DESCRIPTION: There is a need to develop an automated field probe to measure the electromagnetic fields in an anechoic chamber. The current method for chamber characterization involves probing the electromagnetic field manually. This involves the manual placement of field probes and operation of test equipment. This process is manpower intensive and consumes large amounts to test preparation time which decreases the availability of the anechoic chamber. The automated field probe needs to probe an operator defined test volume in the anechoic chamber. The test volume should at least be a rectangular box 80 feet x 80 feet x 60 feet. The probe needs to sample the test volume in operator defined steps. The electromagnetic field perturbations due to the probe must be minimized. The field probe needs to record the data, analyze it and provide characterization data in tabular form and various plots. The probe needs to be programmable and operate automatically. A typical application would be to place the probe in the chamber, set up the field probe run, initiate the run, collect the output data and then remove the probe from the chamber.

PHASE I: Should demonstrate the feasibility of developing a prototype unit

PHASE II: Should result in the demonstration of a prototype unit

POTENTIAL COMMERCIAL MARKET: The technology that will be developed has applications in environments that are hazardous to work in. This type of system could be used to probe and measure electromagnetic fields around radar sites, high power microwave telecommunication links or any environment where the electromagnetic fields are too strong to allow people to work in.

AF96-223 TITLE: Expanded Polystyrene (EPS) Foam Column Research

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop procedures to predict electromagnetic and mechanical characteristics from foam columns given their shape and properties.

DESCRIPTION: To date, much work has been done in an attempt to determine procedures for calculating electromagnetic scatter and mechanical characteristics of EPS. There is still a wide variety of debate concerning how the scattering mechanisms of EPS should be treated. This should be examined in further detail. Combined with the basic research of EPS electromagnetic and mechanical modeling, the size and shape of foam columns must be considered. Foam can be cut in a variety of shapes at Radar Target Scatter (RATSCAT) to include: Ogive, Wedge-Ogive-Wedge, Faceted (such as Hexagonal), and vertically tapered or stepped. A comprehensive electromagnetic and mechanical modeling tools should consider such arbitrary shapes in the overall modeling process as well as the size and shape of the target and the illumination pattern of the radar.

PHASE I: The initial effort should involve extensive research into the areas of EPS modeling, preferably strengthened through comparison to measured data. Once an effective approach is finalized, a proposal should be completed to facilitate implementation of that approach to specific EPS volume geometries.

PHASE II: Research should extend to development of effective modeling software. The software should allow the user to input design parameters such as column shape, foam density, and Electromagnetic (EM) frequency of interest. From these parameters, it should then predict the Radar Cross Section (RCS) of the column. The ultimate goal is a foam column design optimization tool that will provide the least amount of EM scattering for a given target size, weight, and center of gravity.

POTENTIAL COMMERCIAL MARKET: This research could yield important results for the military and commercial sector. If a successful approach is realized, businesses specializing in construction with foam (such as styrofoam cups or pool equipment), could use electromagnetic sources for quality assurance during fabrication/assembly of such products. The Air Force, as well as other DoD agencies, uses EPS target supports extensively in RCS measurements. As radar signature levels of military vehicles become more and more stealthy, efforts must be made to improve measurement facility sensitivity to allow for accurate RCS measurements. It is extremely useful, therefore, to understand the scattering characteristics of target supports used in such measurements and to find a way to minimize their contribution to the measured RCS data.

REFERENCES:

1. RATSCAT In-House, Derivation for Foam Column Scattering, 1991.
2. Plonus, M.A., theoretical Investigation of Scattering from Plastic Foam, IEEE Transactions of Antennas and Propagation, January, pp.88 through 94.
3. Sarkar, Tapan K., Electromagnetic Scattering from Dielectric Bodies, IEEE Transactions on Antennas and Propagation, Vol. 37, No. 5 may 1989, pp. 673 through 676.
4. Ishimaru, Akira, Wave Propagation and Scattering in Random Media, vol 1, Single Scattering and Transport Theory, Academic Press, 1978, pp. 69 through 83 and pp. 175 through 185.
5. E.F. Knott, C.J. Ray, M.S. West, R.J. Wohlers, Radar Background Signal Reduction Study, Final Report, Georgia Institute of Technology, July 1980.
6. Plonus, M.A., A New Reflection Coefficient for Low-Density Dielectrics, Defense Technical Information Center, 7 January 1965.
7. F.A. Albini, E.R. Nagelbert, Scattering of a Plane Wave by an Infinite In-Homogeneous Dielectric Cylinder - An Application of the Born Approximation, Journal of Applied Physics, Vol, 33, No 5, May 1962, pp. 1706 through 1713

AF96-224 TITLE: Remote Operation of a Carrier Phase Receiver

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Communications Networking

OBJECTIVE: Develop innovative hardware and software configurations that will efficiently semi-autonomously transmit and receive data, survey, and fault-monitor an array of remotely located carrier phase receivers.

DESCRIPTION: The Central Inertial Guidance Test Facility (CIGTF), Holloman AFB, NM tests inertial navigation systems

(INS) that have embedded Global Positioning System (GPS) receivers. Precision flight tests of these systems require accurate position, velocity, and attitude information against which the test system can be compared in order to determine accuracy. The current system being developed for CIGTF will include up to 30 remotely located carrier phase receivers. These receivers will be located throughout the White Sands Missile Range (WSMR) complex at locations selected for geometry considerations, covering thousands of square miles of both desert and mountain terrain. As a result, these receiver stations must be highly autonomous, in particular with regard to maintenance and power, as well as data transmission and reception. Additionally, these sights must be surveyed with extreme accuracy. Innovations are required for both hardware and software that allow for real-time data transmission to a control center, real-time data reception from a control center, periodic survey updates, and remote fault monitoring of each sight. Considerations must include the harsh desert and mountain environment of the WSMR complex, sight power requirements, and data transmission rates and methods. These considerations will help drive carrier phase receiver requirements.

PHASE I: Research culminating in the identification and design of candidate components and software requirements for a remote carrier phase receiver station capable of tracking a pseudolite transmitter located on high dynamic aircraft.

PHASE II: Research into the integration of the chosen equipment into an operational system. The output of this phase will be a complete set of integration drawings (mechanical and electrical), a complete design of the system software (Ada programming language required), a test of the system demonstrating the remote and semi-autonomous operation of one receiver site, and a test demonstrating the ability of two or more site to work together.

POTENTIAL COMMERCIAL MARKET: Potential exists in the inertial industry, the test industry, commercial aviation industry, and air traffic control industries.

REFERENCES:

1. 46th Guidance Test Squadron Capabilities Brochure (POC: Capt Tony Nash, (505) 679-2317, DSN 349-2317).
2. Sub-meter Accuracy Reference System II Development Plan, Feb 94 (POC: Capt Tony Nash (505) 679-2317, DSN 349-2317).
3. The Enhanced Performance of an Integrated Navigation System in a Highly Dynamic Environment, Thesis, Brian J. Bohenik, AFIT/GE/ENG/94D-01 (POC: Capt Tony Nash, (505) 679-2317, DSN 349-2317).

AF96-225 TITLE: Non-intrusive Surface Mapping of Ice Contaminated Aero-surfaces

CATEGORY: Exploratory Development
DOD CRITICAL TECHNOLOGY: Aerospace Propulsion and Power

OBJECTIVE: Develop the capabilities to remotely map the ice shape profile (surface) of ice contaminated aero-surfaces on static and rotating surfaces.

DESCRIPTION: The contamination of aero-surfaces such as airfoils and gas-turbine engine components in flight, in icing conditions, alters the flow field. The need exists to determine the profile of the surface ice contamination. An ice contaminated surface can be highly three dimensional and be dry or wet with water. Characterization of the ice shape profile (surface) can be important to the understanding of heat transfer and boundary layer transition. The amount of contamination can be important in flow blockage or impact damage assessments. Ground testing relies heavily upon entry into a test celland manual determination of contamination profiles, a time consuming and expensive process. A technique is required to remotely determine the geometric characteristics of the surface contamination for ground test uses; eliminating the requirement to enter the test cell. The surfaces can then be recreated for wind tunnel, test cell, or flight testing of the aero-surfaces or for laboratory studies of mass and heat transport on or to the surfaces. A successful system will remotely determine surface profiles in less than 5 minutes, resolve the surface within approximately 0.05 inches,and work for both static and rotating engine surfaces. The surfaces to be mapped can be grainy, highly three dimensional, and primarily ice or water covered ice.

In addition to the Phase I Final Report, an educational video, in VHS format, describing the project shall be a required deliverable. The video shall include (1) a discussion of the basic science or physics that is the basis for the proposal (2) a discussion of the various techniques considered or used (3) an actual proof of concept demonstration (4) and a discussion of the results and recommendations. The video must be no less than 40 minutes in length and be suitable for use at the upper level undergraduate or graduate engineering school level.

PHASE I: Analytically and experimentally demonstrate the principles required for a viable non-intrusive surface mapping of ice contaminated aero-surfaces.

PHASE II: Produce a marketable system for general application to remote surface contouring.

POTENTIAL COMMERCIAL MARKET: There is a substantial ground test community that could benefit from the development of the surface mapping capability. Extension to airport operations for military and commercial utilization is foreseen. The surface mapping capability has numerous industrial applications such a machine-shop quality control and feedback for robotics automation. The technique would also have applications for use as a non-contact inspection tool for the tire manufacturing industry and the high-volume production casting industry.

NOTICE: Proposals received by AEDC may be evaluated by base support contractors who are not Air Force employees.

REFERENCES:
1. Olsen, W., Shaw, R.J., and Newton, J. " Ice Shapes and the Resultant Drag Increase for a NACA 0012 Airfoil." NASA-TM-83556, January 1984.
2. Bartlett, C.S. and Phares, W.J. "Icing Testing of a Full Scale Inlet at the Arnold Engineering Development Center." AIAA-93-0299, January 1993.
3. Masiulaniec, K.C., et al, "Experimental Technique for Assessment of Measuring the Connective Heat Transfer from natural Ice Accretions.", AIAA-95-0537, January 1995.

AF96-226 TITLE: <u>Wind Tunnel Bearing/Balance Test Mechanism for Performing Virtual Flight Testing (VFT)</u>

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Air Vehicle/Space Vehicles

OBJECTIVE: Develop a wind tunnel test mechanism that allows the model to "fly" in the wind tunnel and measure model attitude and aerodynamic forces.

DESCRIPTION: Develop a test mechanism that allows a wind tunnel model to pitch and yaw (+ or - 15 deg) and roll (unlimited) on a near frictionless 3 Degree-of-Freedom (3 DOF) pivot while measuring pitch, yaw, and roll attitude (accuracy + or - 0.1 deg pitch and yaw and + or - 0.5 deg roll) and normal, side, and axial forces at less than 10 Hz (accuracy + or - 1/4% full scale). The mechanism should be less than 3 inches in diameter and provide the capability to measure normal and side loads of up to 750 lbf and axial loads of up to 150 lbf. The mechanism must be able to pass up to 5 lbm of air/sec to the model for jet control action during testing. The balance should be able to measure high frequency (100-800 Hz) and low level oscillatory loads (+ or - 30 lbf to 5% accuracy) from time dependent flow phenomenon like vortex shedding.

PHASE I: Develop a 1 DOF (roll only) near frictionless pivot that can measure normal, side, and axial forces, and pitching and yawing moments. The balance should measure both high and low frequency loads and pass air to the model for jet control action during testing.

PHASE II: Develop a prototype 3 DOF mechanism as described above.

POTENTIAL COMMERCIAL MARKET: The need for this device exists at aerospace test facilities around the world. As military flight speeds increase and fuel economy affects the profits of the commercial airlines, the need for accurate and reliable test data has becomes increasingly critical. With the availability of this device, test facilities will be able to provide the commercial market with superior data for product development. Its use in validating model response to test inputs will also be invaluable for the continued advancement of flight simulators. As automobile manufacturers look to aerodynamic testing of their new products in their quest to optimize fuel economy and maneuverability, the market for this device will expand rapidly.

NOTICE: Proposals received by AEDC may be evaluated by base support contractors who are not Air Force employees.

REFERENCES:
Marquart, E. J. "An Assessment of a Potential Test Technique: Virtual Flight Testing" AIAA Paper 95-3415.

AF96-227 TITLE: 6-DOF Angular Acceleration Calibration Device for Subscale Ground Testing

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop a calibration device/s for subscale vehicle trajectory and launch loading experiments with low and high "g" applications.

DESCRIPTION: The development of g-hardened subminiature telemetry for the transmission of 6-DOF acceleration data is an ongoing effort at AEDC. The development effort has two major areas of interest; the determination of the trajectory, forces, and moments of a subscale free-falling vehicle in a wind tunnel environment and the determination of the dynamic loading of a subscale vehicle traversing the launch tube of a two-stage light-gas gun (Range G). A necessary step prior to testing is the calibration of the accelerometers and/or the test vehicle. Knowledge of the precise locations of the accelerometers with respect to the vehicle, along with highly accurate accelerometer response curves, is required for proper interpretation of the transmitted data. It is desired to achieve uncertainties of less than one percent for both the accelerometer location and response curves. Precise location of the accelerometers is difficult to achieve and costly through fabrication alone. Conventional means of calibrating accelerometers such as centrifuges, vibrators, or impulse rams are inadequate; the calibration must be dynamic and off-axis contributions must be negligible. Other means of calibrating the accelerometers that meet the following test design parameters must be devised.

For AEDC's wind tunnels: Sensor Response Frequency 5 kHz Accelerometer Range + or - 500g.
For AEDC's "Range G": Sensor Frequency Response 40 kHz Axial Accelerometer Range 100,000g Lateral Accelerometer Range 25,000g.

In addition to the Phase I Final Report, an educational video, in VHS format, describing the project shall be a required deliverable. The video shall include (1) a discussion of the basic science or physics that is the basis for the proposal (2) a discussion of the various techniques considered or used (3) an actual proof of concept demonstration (4) and a discussion of the results and recommendations. The video must be no less than 40 minutes in length and be suitable for use at the upper level undergraduate or graduate engineering school level.

PHASE I: Demonstrate the technologies to fabricate and calibrate the device(s).

PHASE II: Fabricate the device(s) and demonstrate the ability of the device(s) to accurately calibrate two representative wind tunnel and two representative Range G vehicles.

POTENTIAL COMMERCIAL MARKET: The calibration device(s) will be used by the military in the evaluation and calibration of accelerometers for both free-flight and in-barrel test programs. This technology can be transferred to the accelerometer manufacturers and to the automotive industry. These devices, if successful, will be suitable for use in conjunction with health monitoring systems in high speed rotating equipment such as stationary gas turbine generators. Also of value, is the application of these device(s) in the new generation of small, lightweight space vehicles envisioned for the commercialization of space.

NOTICE: Proposals received by AEDC may be evaluated by base support contractors who are not Air Force employees.

REFERENCES:
1. Cable, A. J. "Upgrade of Ballistic Ranges at AEDC, Status as of Oct 1993," AIAA-94-0542
2. Marquart, E. J. "Development of a Kinematic Telemetry Test Technique For Ground Test Applications in the AEDC Wind Tunnels, Space Chambers, and Gun Ranges," 18th Aerospace Ground Testing Conference, June 20-23, 1994, Colorado Springs, CO

AF96-228 TITLE: Vibration Analysis of Rotating Plant Machinery

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Aerospace Propulsion and Power

OBJECTIVE: Develop advanced signal processing techniques to perform facility vibration analyses.

DESCRIPTION: Several long-term vibration problems at AEDC have combined to deplete thousands of labor-hours from

maintenance resources. These problems, involving compressors and synchronous motors, continue to threaten testing operations and the maintenance budget with a significant risk of catastrophic failure. Recent advances in high-speed signal processing techniques have allowed researchers to identify anomalous frequencies in the vibration spectra as fault or no-fault conditions in similar rotating components. These techniques could be used to identify vibratory excitation sources and isolate potentially damaging responses in facility hardware systems. Once demonstrated, these techniques could be extended to health monitoring and detailed analysis of turbine and liquid rocket engine test articles. The objective is to develop advanced signal processing techniques that meet the following criteria in facility applications: (1) be able to identify resonances induced by neighboring equipment (2) be able to distinguish between acoustically and mechanically driven vibration (3) be able to discern electrical faults from mechanical faults in synchronous and induction motors (4) improve the signal-to-noise ratio in conventional facility vibration data (5) include source-point identification (6) and resolve rotor-related responses from anomalous frequencies and/or noise.

In addition to the Phase I Final Report, an educational video, in VHS format, describing the project shall be a required deliverable. The video shall include (1) a discussion of the basic science or physics that is the basis for the proposal (2) a discussion of the various techniques considered or used (3) an actual proof of concept demonstration (4) and a discussion of the results and recommendations. The video must be no less than 40 minutes in length and be suitable for use at the upper level undergraduate or graduate engineering school level.

PHASE I: Analytically and experimentally demonstrate the principles required for a vibration analysis of rotating plant machinery.

PHASE II: Produce a prototype system for general application to rotating machinery health-monitoring for test cell and wind tunnel applications.

POTENTIAL COMMERCIAL MARKET: The commercialization potential for such a device is extensive. Heavy industries and utilities using large motors, compressors, and pumps will be able to avoid in-service catastrophic failures by early warning of system anomalies. Commercial jet engine maintenance and overhaul facilities will be able to accurately determine the actual condition of an engine; possibly avoiding unnecessary and costly premature overhauls.

NOTICE: Proposals received by AEDC may be evaluated by base support contractors who are not Air Force employees.

REFERENCES:
Sid W. Hite, "An Algorithm For Determination of Bearing Health Through Automated Vibration Monitoring" AEDC-TR-93-19, Dec 1993

ADVANCED RESEARCH PROJECTS AGENCY
Submission of Proposals

ARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the ARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military and dual-use applicability as the budget and other factors will allow.

ARPA has identified 44 technical topics, numbered **ARPA SB961-001** through **ARPA SB961-044**, to which small businesses may respond in the first fiscal year (FY) 96 solicitation (96.1). Please note that these are the only topics for which proposals will be accepted at this time. A list of the topics currently eligible for proposal submission is included, followed by full topic descriptions. The topics originated from ARPA technical offices.

ARPA Phase I awards are limited to **$99,000**. ARPA Phase II proposals must be invited by the respective Phase I technical monitor. Phase II proposals are encouraged at the amount of $375,000; however, additional funding may be available for optional tasks, for a total contract value not to exceed $750,000.

The responsibility for implementing ARPA's SBIR Program rests with the Office of Administration and Small Business (OASB). The ARPA SBIR Program Manager is Ms. Connie Jacobs. ARPA invites the small business community to send proposals directly to ARPA at the following address:

ARPA/OASB/SBIR
Attention: Ms. Connie Jacobs
3701 North Fairfax Drive
Arlington, VA 22203-1714
(703) 696-2448

The proposals will be processed by ARPA OASB and distributed to the appropriate technical office for evaluation and action.

ARPA selects proposals for funding based upon technical merit and the evaluation criteria contained in this solicitation document. As funding is limited, ARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the ARPA mission. As a result, ARPA may fund more than one proposal in a specific topic area if the technical quality of the proposal(s) in question is deemed superior, or it may fund no proposals in a topic area. Each proposal submitted to ARPA must have a topic number and must be responsive to only one topic.

A checklist has been prepared to assist small business activities in responding to ARPA topics. Please use this checklist prior to mailing or hand-carrying your proposal(s) to ARPA. One additional photocopy of Appendices A & B is requested. Do not include the checklist with your proposal.

ARPA 1996 Phase I SBIR
Checklist

1) Proposal Format

a. Cover Sheet - Appendix A (identify topic number) ______

b. Project Summary - Appendix B ______

c. Identification and Significance of Problem or Opportunity ______

d. Phase I Technical Objectives ______

e. Phase I Work Plan ______

f. Related Work ______

g. Relationship with Future Research and/or Development ______

h. Potential Post Applications ______

i. Key Personnel ______

j. Facilities/Equipment ______

k. Consultant ______

l. Prior, Current, or Pending Support ______

m. Cost Proposal (see Appendix C of this Solicitation) ______

n. Prior SBIR Awards ______

2) Bindings

a. Staple proposals in upper left-hand corner. ______

b. **Do not** use a cover. ______

c. **Do not** use special bindings. ______

3) Page Limitation

a. Total for each proposal is 25 pages inclusive of cost proposal and resumes. ______

b. Beyond the 25 page limit do not send appendices, attachments and/or additional references. ______

4) Submission Requirement for Each Proposal

a. Original proposal, including signed **RED** Appendices A and B. ______

b. Four photocopies of original proposal, including signed Appendices A and B. ______

c. One additional photocopy of Appendices A and B only. ______

INDEX OF ARPA FY 96.1 TOPICS

ARPA SB961-027	Magneto-Rheological (MR) Fluids, Devices, and Applications
ARPA SB961-028	Optical Network Switching Technology
ARPA SB961-029	Materials and Process Technologies for Low-Power Semiconductor Circuits
ARPA SB961-030	Maskless Lithography for Microelectronic Devices with Features of 0.1 Microns
ARPA SB961-031	Virtual Prototyping Tools for Semiconductor Fabrication Equipment
ARPA SB961-032	Low-Noise Optical Amplifier
ARPA SB961-033	Development of Techniques to Ruggedize Graded Index Communication Grade Plastic Optical Fiber
ARPA SB961-034	Miniature Environmental Air Sampler for Biological Materials into Fluid
ARPA SB961-035	Detection and Characterization of Underground Facilities (UGF)
ARPA SB961-036	Small Chemical and Biological Agent Sensors
ARPA SB961-037	Video Retrieval Based on Language and Image Analysis
ARPA SB961-038	Lightweight, Low-Cost Surveillance Arrays
ARPA SB961-039	Computational Intelligence Approaches to Automatic Target Recognition (ATR)
ARPA SB961-040	Alternate Power Sources for Aerostats
ARPA SB961-041	Rapid Target Model Development and Validation
ARPA SB961-042	Development of Holographic Memory for Use In Optical Correlators
ARPA SB961-043	Non-Linear Optic Materials for Protection of Optical and Electro-Optical Sensors
ARPA SB961-044	Millimeter Wave/Infrared Dichroic Beam Combiner

SUBJECT/WORD INDEX TO THE ARPA FY96.1 TOPICS

ARPA 96.1 TOPIC DESCRIPTIONS

ARPA SB961-001 TITLE: Critical Components for Hybrid Electric Power Systems

CATEGORY: 6.2 Exploratory Development; Electric Power, Pulse Power

OBJECTIVE: Develop and demonstrate system architectures, critical components, and/or component subsystems for hybrid electric power systems.

DESCRIPTION: Research and develop key enabling hybrid electric power system technologies for future combat vehicles. Efforts may address any technology for hybrid electric power systems for which significant leverage can be demonstrated, however, power averaging, conditioning, distribution, and control devices are of particular interest. The focus of this effort is on integrated power systems and not on the development of electrically powered subsystems. Efforts should address an integrated power system or its components, capable of powering multiple loads, such as gigawatt pulse power for weapons and megawatt continuous power for propulsion. Energy density, power density, thermal management, and cost are critical parameters.

PHASE I: Design the system architecture, component, and/or component subsystem for a future combat vehicle hybrid electric power system and demonstrate feasibility through modeling, simulation, virtual prototyping, or laboratory demonstration. Define an approach for full-scale development, including a cost analysis and test plan for validation of performance. Complete documentation of designs and feasibility test results must be delivered.

PHASE II: Develop full-scale prototype and/or subscale prototype with scaling algorithms from Phase I design and implement test plan to validate performance. Evaluate Phase I models, simulations, or virtual prototypes using Phase II test data. Complete documentation of prototype and test results must be delivered. Develop and provide a plan to manufacture the developed prototype.

COMMERCIAL POTENTIAL: The development of critical components for hybrid electric power systems will expand commercial markets for the growing light and heavy-duty electric and hybrid vehicle industry; support the electrical utilities in power load leveling, uninterruptable power supply, and power distribution; enable enhanced safety and control for aircraft with electric actuators and high temperature power electronics; support space station power distribution systems; and electric drive ship systems. Realize significant cost reductions due to dual-use high volume production and component scalability.

REFERENCES:
1) "Future Combat Vehicles Hybrid Electric Power Briefing," Advanced Research Projects Agency, 195. Requests for these viewgraphs should be directed to (703) 696-2448.
2) Institute of Physics Conference Series Number 141, "Proceedings of the Twenty-First International Symposium on Compound Semiconductors," held in San Diego, California 18-22 September 1994.
3) Scientific American, "High-Power Electronics," November 1993.
4) National Research Council, STAR 21: Strategic Technologies for the Army of the Twenty-First Century, ISBN 0-309-04629-7, National Academy Press, 1992.
5) Rodler, W. E., Shafer, K. W., "Electric Drive Study," U.S. Army Tank Automotive Command, Contract DAAE07-84-C-R017, December 1987, DTIC AD Number: A255058.

ARPA SB961-002 TITLE: Improved Representation of Human Behavior in Simulation

CATEGORY: 6.2 Exploratory Development; Modeling and Simulation

OBJECTIVE: Create realistic Artificial Intelligence (AI) technologies to realistically represent human behavior.

DESCRIPTION: Current representation of human behavior in simulation is still rudimentary, based largely on simple rule sets. ARPA is seeking AI technologies which will allow improved representations of this behavior at a reasonable cost in terms of computing resources. Solving this requirement is fundamental to the improvement of simulation throughout DoD.

PHASE I: Design and execution plan for a prototype of human behavior in computer generated forces.

PHASE II: Create a prototype in a service specific mission area.

COMMERCIAL POTENTIAL: There is significant potential within civilian industry, particularly the entertainment industry, for the use of this technology. Creating technologies that enhance a computer's ability to emulate human behavior has applicability in all areas of civilian industry.

REFERENCES:

1) Garrett, R. 1995. "ADS: Looking Toward the Future." *Phalanx,* June, 1995, 9-11.
2) Hayes-Roth, B. 1993. "On Building Integrated Cognitive Agents: A Review of Allen Newell's Unified Theories of Cognition." *Artificial Intelligence 59:329-341.*
3) Laird, J.E.; R.M. Jones; and P.E. Nielsen 1994. "Coordinated Behavior of Computer Generated Forces in TacAir-Soar." In the Proceedings of the Fourth Conference on Computer-Generated Forces and Behavioral Representation, 325-332/ Orlando, Fl.: University of Central Florida Institute for Simulation and Training.
4) Nelson, G.; Lehman, J.F.; and John, B.E. 1994. "Integrating Cognitive Capabilities in a Real-Time Task." In *Proceedings of the Sixteenth Annual Conference of the Cognitive Science Society.* Hillsdale, N.J.: Lawrence Erlbaum.

ARPA SB961-003 TITLE: <u>Ultra-High Performance Antennas for Communications-on- the-Move (COTM)</u>

CATEGORY: 6.2 Exploratory Development; Command, Control and Communications

OBJECTIVE: Design, develop, and test ultra-high performance antennas in support of communications-on-the-move (COTM) for airborne and ground platforms.

DESCRIPTION: The military is in the process of developing programmable, multiband, multimode radios that provide multiple, simultaneous transmit and receive channels in the frequency range of 2 MHz to 2 GHz to support the digitization of the battlefield. New, advanced ultra-wideband antenna concepts, subsystems and components that support multiple, simultaneous transmission and/or reception need to be developed to exploit advanced radio capabilities, such as reprogrammability and frequency agility.

Ultra-widebeam antennas are required to provide communications capabilities using a high altitude endurance (HAE) unmanned aerial vehicle (UAV) and mobile ground platforms. These capabilities include broadband relay services and broadcast services for dissemination of wideband digital information. UAV antennas with ultra-wide beamwidths increase the coverage area to enable COTM and simplify payload design. Ultra-widebeam antennas in ground platforms provide COTM capability, ensure rapid access of service and simplify ground terminal design. Multimode operation supports beamwidth expansion and may provide simultaneous and/or switched multifunction operation in support of multiple communications system requirements.

PHASE I: Identify concepts/approaches for ultra-wideband and ultra-widebeam antennas, subsystems, and components. Define trade space for ultra-wideband antennas. Identify trades for performance capabilities versus beamwidth of ultra-widebeam antennas, including simultaneous and/or switched multimode, multifunction operation. Develop range of baseline designs based on trade studies. Define Phase II approach.

PHASE II: Fabricate the selected ultra-wideband and ultra-widebeam antennas/subsystems. Obtain complete characterization of the antennas and demonstrate performance.

COMMERCIAL POTENTIAL: Ultra-wideband antennas will support simultaneous communications on a variety of commercial communications systems, such as cellular, personal communications systems and Mobile Satellite Systems (Iridium). The multimode, multifunction, ultra-widebeam antenna has significant commercial potential for COTM applications, including mobile SATCOM, cellular and broadcast services. Multifunctionality will result in reduced costs, size, and weight, all of which benefit commercial systems in addition to promoting solutions to technical issues (co-site interference, etc.).

REFERENCES:

Strugatsky, Alexander and Dr. C. H. Walter, "Multimode Multiband Antenna", Proceedings of the Tactical Communications Conference, Fort Wayne, IN, 28, April 28-30, 1992.

ARPA SB961-004 TITLE: <u>Collaborative Tools for Building Virtual Worlds</u>

CATEGORY: 6.2 Exploratory Development; Modeling and Simulation

OBJECTIVE: Create collaborative tools and processes capable of linking disparate source materials, diverse domain knowledge,

and interdisciplinary experts, at specialized workstations in distributed systems, to support efficient generation of 3-D virtual worlds for modeling and simulation applications.

DESCRIPTION: Research and development leading to collaborative tools to link disparate source materials and diverse domain knowledge for efficient generation of 3-D virtual worlds supporting modeling and simulation applications. It is anticipated that proposals will incorporate capabilities of computer aided design workstations, digital map data repositories, expert systems, geographic information systems, and softcopy image exploitation workstations in distributed systems linked by local and wide area networks. Such capabilities can link interdisciplinary teams which may include cartographers, simulation data base modelers, terrain analysts, and application specialists representing the end user. Military applications include training, analysis, situational awareness, mission planning, and mission rehearsal. The technology needs to be adaptable to support diverse military applications ranging from theater-level operations by a Joint Task Force, to special operations conducted by individual combatants at the appropriate levels of resolution and detail.

PHASE I: Design distributed system concepts, architecture, and processes needed to link disparate source materials, algorithms, domain knowledge, and experts, with collaborative tools for spatial data integration, to create geospecific virtual worlds. Specify a lossless approach to interchange the assembled virtual world with external applications such as real-time visualization and synthetic forces in Advanced Distributed Simulation. Design and assemble source materials for one or more test cases.

PHASE II: Implement and demonstrate a distributed system, linking disparate source materials, algorithms, domain knowledge, and experts, with collaborative tools for spatial data integration, to create geospecific virtual worlds. Use a lossless interchange mechanism assembled virtual world with external applications to include real-time visualization on multiple platforms and synthetic forces in Advanced Distributed Simulation. Complete documentation of test cases and results must be delivered.

COMMERCIAL POTENTIAL: The development of flexible, adaptive capabilities to create geospecific virtual worlds, integrating digital map data, all-source imagery, and domain-specific expertise, will expand the commercial market to address a broad spectrum of military, architectural, land use planning, and entertainment applications. Potential commercial products hold the promise for generating higher quality digital terrain models with dramatic reductions in the time required.

REFERENCES:
1) Paul Birkel, Carol Chiang, Steve Farsai, Farid Mamaghani, David Pratt, and Joshua Smith. "Synthetic Environment Data Representation and Interchange Specification (SEDRIS)." In 12th Workshop on Standards for the Interoperability of Distributed Simulations, Institute for Simulation and Training, March 1995.
2) DIS Vision Document, Technical Report IST-SP-94-01, Institute for Simulation and Training, May 1994. (available via WWW, see address below)
3) DoD Modeling and Simulation Master Plan, Defense Modeling and Simulation Office, Alexandria, VA, 1995. (available via WWW, see address below)
4) Synthetic Environments Data Representation Interchange Specification (World Wide Web: http://www.dmso.mil/).

ARPA SB961-005 TITLE: Novel Techniques to Deflect Bullets for Body Armor and Helmets

CATEGORY: 6.2 Exploratory Development; Personal Survivability Systems

OBJECTIVE: Develop extremely lightweight materials and designs, which will protect individuals through deflection of bullets, as compared to today's heavyweight concepts of protection through stopping the bullet.

DESCRIPTION: Research and development leading to the design of extremely lightweight body armor, extremity armor, and helmets that protect the individual through bullet deflection instead of stopping the bullet. Current standard military (approx 9 lbs) vests were designed to stop fragments, not rifle bullets. Approximately two million of these vests have been produced. Bullet protection is now desired. Current state-of-the-art methods involve heavy plates (up to 10 lbs/square foot) to stop 7.62mm armor piercing (AP) bullet threats. Substantial R&D efforts exist to reduce the weight to 5.5 lbs/square foot. This weight is viewed as the lower limit to stop AP rounds and is still too heavy to provide substantial body coverage for the user. The proposed R&D effort seeks materials, ballistic designs, and configuration, such that bullets can be deflected away from the individual through the combination of obliquity surfaces the soldier presents in his fighting positions (standing and prone). Extremity configurations should weigh between 1.5 to 2.0 lbs/square foot. Designs should minimize interference with the soldier's motion. Total designs should be between the weight of the current flack vest, 9 lbs, and Ranger body armor of 18 lbs. Helmet designs should be within the weight of the current helmet (3.3 lbs). Surface coating techniques should also be examined.

PHASE I: In detail, define, design, and test ballistic flat plate samples at oblique angles, representative of angles a soldier presents in a standing and prone fighting position. Present full system concept designs for integration on to the individual, complete with weight estimates, ballistic coverage, ballistic holes, and bullet deflection paths.

PHASE II: Design and build four systems of one or more designs for ballistic and user testing.

COMMERCIAL POTENTIAL: Body armor markets are substantial for military and law enforcement agencies. Commercial use could extend to security guards, special persons protection, and private citizen use.

ARPA SB961-006 TITLE: Graphical Visualization of Cyberspace

CATEGORY: 6.2 Exploratory Development; Computing and Software

OBJECTIVE: Develop capabilities for intelligent graphical browsing and retrieval tools that will allow users to effectively browse the vast amount of information available in Cyberspace.

DESCRIPTION: The explosion of information available on the Internet has resulted in a significant problem of user interface - how can users browse such information to find items of interest? The goal of this effort is to develop capabilities for intelligent graphical browsing and retrieval tools that will allow users to effectively browse the vast amount of information available in Cyberspace. These tools will exploit both the advances in graphical techniques for dealing with large data sets, as well as methods (i.e., World Wide Web) that allow for the integration of disparate networked information. Possible technologies and example products include, but are not limited to, the following: 1) generic and domain-specific methods for representing information in 3-D models suitable for rendering and visualization, 2) methods for gathering specified subsets of data from Cyberspace and providing access through graphical visualization, and 3) tools that implement the above and support graphical browsing of the Internet. The visualization paradigms should be able to deal with both information that has natural physical models as a basis for visualization, as well as more abstract information that has no natural physical model.

PHASE I: In detail, define and do a preliminary demonstration of techniques that will support intelligent graphical browsing.

PHASE II: Develop a prototype system that implements the techniques defined in Phase I, and conduct sufficient user testing to validate the approach. Complete documentation of test cases and results must be delivered.

COMMERCIAL POTENTIAL: Development of sophisticated graphical browsing techniques will increase the commercial value of information on the Internet and result in an increased commercial market for such information. It will also permit a wider set of users to access and utilize such information.

REFERENCES:
Online information through http://www.csto.arpa.mil and http://www.hpcc.gov

ARPA SB961-007 TITLE: Security in Workflow Processes

CATEGORY: 6.2 Exploratory Development; Computing and Software

OBJECTIVE: Explore and develop innovative reference implementations for the enforcement of various, composable, domain-oriented, workflow security policies, and encourage such investigations specifically for medical record administration and handling, and manufacturing.

DESCRIPTION: Workflow processes control what information will be processed by which individual person, tool, program, and/or machine, and the timing of that processing. The processes may be demand-driven and/or supply-driven. The flow may be information to be worked on (e.g., documents), it may be tokens (e.g., authorizations or obligations) that enable or mandate process actions along with a reference to the work item, or it may be both token and information. The controls may be distributed to each processing element or linked through an application (workflow) framework that controls interactions to underlying persistent objects. Such controls are vulnerable to disruption if their security is not built into their design and implementation. However, achieving such security poses unique workflow design requirements in dealing with the domain-specific information life-cycles, information ownership, provenance, origination, usage, roles, authentication, authorization, access, release, integrity, availability, confidentiality, privacy, sharing, inference, storage, retrieval, transmission, retention,

auditing, and security administration. Protection, in the workflow context, must consider the use of general purpose applications as well as domain-specific applications.

Investigation efforts which include small teams of workflow, domain-specific, and security expertise are encouraged. Innovations should include workflow-control protection enforcement via protocols, or by application programming interfaces to underlying protection mechanisms; considered use of multi-function smartcards; incorporation of satellite and wireless operations; and protection incorporated across the infrastructure of a large-scale distributed system. Such innovations should strive to produce a level of trust and robustness that reduces the required amount of overall system assurance evaluation (e.g., through the use of reusable, composable, and interoperable modules and/or security protocols that support workflow concepts). Innovative solutions to such requirements will properly integrate and/or link common core and extendible elements of security policy enforcement mechanisms. Such security policies should have components that are enforced system wide, and components that are user settable. Particular attention should be paid to design issues to ensure that controls cannot be thwarted or bypassed in unauthorized ways.

PHASE I: Conduct a six month study that develops and validates a distributed system model of workflow security within the medical or manufacturing domain. Such a model should cover the entire lifecycle of information within the domain. Demonstrate, through the model, how security policies may be composed, modified, and extended to meet changes in workflow processes. Provide an initial assessment, based on the model, of the scalability and cost of security management associated with workflow protection in large-scale systems. Perform a general assessment of security support provided by current workflow development tools and frameworks available to support the model.

PHASE II: Design and prototype the modeled secure, distributed workflow system. Confirm the resulting utility and security of the system within the model's domain (e.g., hospital, clinic, or manufacturing floor). Confirm previous assessments developed in Phase I through experimental tests with the prototype system within the domain. Demonstrate adaptability and extendibility of the prototype. Demonstrate documented assurance associated with the design and development of the prototype.

COMMERCIAL POTENTIAL: This technology is directly applicable to enhancing the productivity in both military and civilian domains.

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ARPA SB961-008 TITLE: Microsystems, Microarchitectures, and Components

CATEGORY: 6.2 Exploratory Development; Computing and Software, Electronics

OBJECTIVE: Achieving the goal of an affordable defense requires leveraging commodity microelectronic components to develop scalable computing and information systems. Existing commodity components are inadequate to meet the demands of defense applications. Specifically, in the critical area of embedded and mobile information systems, the performance of these systems is limited by the power consumed by microsystems components, the gain and efficiency of miniature antenna systems, and the flexibility and adaptation of microarchitectures. This topic solicits innovative research in these focused areas to enhance commercial technologies to meet the needs of Defense.

DESCRIPTION: The performance and applicability of commodity microelectronics components to defense embedded and mobile computing applications is limited by the power consumed by the microprocessor, memory, and communications elements. This topic solicits novel approaches at the microarchitecture level to fundamentally reduce the power consumed by commodity processor-based systems. Techniques proposed should exploit the integrated circuit process level techniques, such as voltage scaling, but should principally focus on circuit, architecture, and system level techniques to bring substantial power savings to computing applications.

A second, but related element solicits techniques for configurable computing that enhance system efficiency and performance across a diverse set of Defense applications. Ideas might include dynamic re-configuration, adaption to environments, or enhancements for security or reliability that significantly improve system utility. Proposals could address the hardware architecture of configurable components, the system architectures of a configurable system, or the design technology to support this model of computing (e.g. compiler technology). Applications span hand-held mobile computing systems to embedded scalable high-performance computing systems.

The third critical element seeks miniature antenna technology to support dramatic improvements in information rates, range, and user population for distributed wireless information systems. Proposals might address low-cost production methods for microstrip or other planar/conformal antenna structures to significantly improve performance over vertical or dipole elements. Directional antenna approaches that can be integrated into hand-held or portable information system elements are specifically of interest. Applications include digital battlefield and special force.

PHASE I: Design, simulation, and concept phase, with sufficient results to validate the assumptions and quantify the benefits of the approach. Define the metrics to be used in Phase II.

PHASE II: Prototype phase, with functional demonstrations in a systems context to validate the approach and simulation results. Phase II report must include plans to commercialize results of the research and define how the technology will be made available to Defense.

COMMERCIAL POTENTIAL: Elements of an affordable Defense must leverage commercial technology. This topic requests microelectronics technology that leverages and extends the commercial technology base. Power reduction techniques will benefit the hand-held wireless commercial market as well as the personal and portable computer markets. Configurable computing approaches of direct benefit to Defense are likely to be an efficient and low-cost alternative for industrial embedded computing applications such as industrial control. Application of miniature high performance antenna technology will yield technically superior, commercially viable, and widely marketable antenna products for such markets as the rapidly growing personal wireless communication market.

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World Wide Web: ARPA Home Page: http://www.arpa.mil

ARPA SB961-009 TITLE: Scalable Software Libraries for High Performance and Embedded Scalable Computing Systems

CATEGORY: 6.2 Exploratory Development; Computing and Software

OBJECTIVE: Develop libraries suitable for heterogeneous scalable systems (e.g., from a single workstation, to a heterogenous collection of workstations, to a massively parallel processor). Of particular interest is the definition of a set of APIs for the libraries that will be applicable across the entire range of interest.

DESCRIPTION: ARPA seeks research into scalable software libraries that will enable the rapid development of scalable code and its portability across a wide range of scalable systems. This includes integration of library technology, ranging from low-level functions, such as the BLAS, to high-level functions, such as sparse solvers, into scalable HPC languages. In addition, innovative libraries for supporting computation and communication over scalable heterogeneous systems are sought. Topics of interest also include object-oriented class libraries for signal/sonar/image processing for scalable heterogeneous HPC systems. Also of interest in this area is the development of domain specific tools that are also scalable and portable. Examples of such tools are Khoros in the area of image processing. Any tools so developed should exploit existing libraries, such as BLAS, to reduce the development effort and enhance portability.

PHASE I: Requirements analysis, market analysis, approach definition, high-level design and test methodology, documentation, and marketing approach.

PHASE II: Detailed design, implementation, performance analysis and tuning, portability and scalability demonstration, and user and programmer documentation.

COMMERCIAL POTENTIAL: The 2X improvement in processor performance has resulted in users migrating from processor to processor in search of improved performance. At the same time, reductions in cost have necessitated the utilization of the minimal system capable of doing a task with a requirement that additional processing/communication resources will be added as funds develop. Both issues dictate a demand for commercial libraries that are both portable and scalable to meet these challenging demands in a transparent and cost-effective manner.

ARPA SB961-010 TITLE: Security Tools

CATEGORY: 6.2 Exploratory Development; Computing and Software

OBJECTIVE: Enhance and/or expand the set of administrative, analytical, and diagnostic tools available to security administrators, security auditors, and systems administrators across the spectrum of heterogeneous networked and distributed systems.

DESCRIPTION: Research and development leading to security tools with broad applicability to today's widely fielded, heterogeneous systems. Examples are tools for configuration checking (to ensure a system configuration is secure), intrusion detection (continuous monitoring and detection of suspicious activity), self-test and diagnostics, and penetration analysis (for rapid damage assessment and system recovery). Tools that aid in the selection, collection, reduction, and use of computer and network audit data are vital to intrusion detection and to accountability in after-the-fact reactions to security incidents. Tools to establish timely and cogent anomaly patterns that reflect possible incidents are needed, especially in large-scale, heterogeneous, distributed systems. Some audit analysis tools will be more appropriate for off-line operations, while others are needed to support real-time operations. Novel approaches are desired for tools that will: 1) improve the capture of security-relevant information in real-time with reductions in both system processing overhead and human intervention, 2) reduce the labor-intensive operations associated with incident response, and 3) improve testing of the effectiveness and efficiency of firewall filtering. Proposals must clearly state the analytical methods to be employed, and must include a task that evaluates the success of the methods for the application. Earlier techniques and tools that were taken as far as the proof-of-concept stage may be reused and extended. Proposals to enhance existing tools to make them more broadly applicable will also be considered. The capabilities of these new or enhanced tools should go well beyond what has previously been done. Solutions must be scalable for use in extremely large, heterogeneous computing and communications networks. Special attention must be paid to ease of use and ease of management. Proposals must clearly state the scale of system targeted.

PHASE I: In detail, define the application, the analytical techniques or algorithms to be used, the approach to, and limits of, scalability, and quantify the expected benefits. Produce a detailed design of the tool to be implemented.

PHASE II: Produce a prototype of the tool, its documentation, and an experimental evaluation of its effectiveness. Complete documentation of test cases and results must be delivered.

COMMERCIAL POTENTIAL: The development of scalable, easy-to-use security tools that can be used to analyze very large, heterogeneous, computing and communications systems will help feed the growing market for tools to safeguard systems from attack by insiders or external penetrators, and to help security managers perform their jobs without need for extensive security expertise. These tools can help to establish new markets for security tools and services. For example, tools to check security configuration can be used by a commercial security certification service, and tools for damage assessment and incident recovery can be used by a commercial incident response service.

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ARPA SB961-011 TITLE: Optical Network Security Technology

CATEGORY: 6.2 Exploratory Development; Information Technology

OBJECTIVE: Develop network security technology for the broadband all-optical networks.

DESCRIPTION: Recent advances in optical network technology have demonstrated the scalable bandwidth capability, as well as the data format transparency, i.e., no electronic regeneration, in laboratory optical network testbeds. This solicitation aims to exploit these features of optical network to develop unique optical network security technology for future all-optical network transmission. Potential candidates must be compatible with some of the ongoing or planned DoD optical network testbeds. These testbeds are (or will be) running at 2.48 Gb/s per channel, and may have multiple wavelengths (four to eight).

PHASE I: Effort should emphasize the demonstration of the basic unique idea either in the laboratory, or by simulation and modeling.

PHASE II: Effort should be a more elaborate demonstration at an appropriate DoD network testbed.

COMMERCIAL POTENTIAL: This telecommunication security program will benefit the medical and manufacturing community by protecting images with a very high bandwidth, such as medical images and manufacturing blueprints.

REFERENCES:

R&D for the NII: Technical Challenges, EDUCOM, 1994.

ARPA SB961-012 TITLE: Nanostructural Materials

CATEGORY: 6.1 Basic Research; Materials, Processes and Structures

OBJECTIVE: Advance the technology and production/manufacturing of nanostructural materials and their fabrication into components, and accelerate the transition of unique materials from the laboratory into reliable, reproducible, economic, commercial-scale production.

DESCRIPTION: Materials having feature sizes (i.e., grain or particle sizes, layer thicknesses) in the nanometer-scale range (1 to 100nm) are currently being developed for a wide range of applications. Among such potential applications are catalytic supports and devices, sensors, filters, electronics, thermal and electromagnetic protection coatings, wear resistant coatings, electrical storage and generation systems, and optical and structural components. These materials offer unique physical properties (i.e., hardness/wear resistance, optical, dielectric, magnetic, mechanical, biocompatibility), transport properties (i.e., thermal, atomic diffusion), and improved processing characteristics (i.e., faster sintering kinetics, superplastic forming). Current fundamental research programs are investigating, for example, new materials, and new process/synthesis methods, such as molecular self-assembly, microstructure-property relationships, transport phenomena, and modeling of the kinetics and thermodynamics with respect to microstructure and processing. Examples of typical processing methods include vapor-phase synthesis (e.g., CVD, PVD, VLS synthesis), mechanical milling of solids, and solution chemistry (e.g., organic precursors). Technical challenges include process scale-up, fabrication of large parts without loss of the critical feature size, control of the distribution and morphology of phases in bulk quantities, and demonstration of performance in prototype components and systems. Proposed efforts may involve materials development, synthesis and processing methods development, component

fabrication, and in-situ process monitoring and control.

PHASE I: Identify and develop a technological advancement in the manufacturing of nanostructural materials and their fabrication into components. Justify the basis for the proposed advancement via consideration of scientific, technical, manufacturability, and affordability issues. Demonstrate feasibility of the process and performance of the materials. Select a relevant military application for demonstration in Phase II.

PHASE II: Demonstrate the capabilities of the proposed technology via a specific material, class of materials, component, or class of components. Evaluate materials and component performance relative to a baseline. Specifically address manufacturability, reproducibility, technical feasibility, and affordability for process scale-up.

MILITARY NEED: Unique materials (e.g., high temperature alloys, composites, semi-conductors) have repeatedly provided the basis for critical military capabilities. Nanoscale materials offer unique electrical, optical, chemical, and mechanical properties of potential benefit in a range of defense applications. Military use requires commercial availability of new materials, and commercial development of new materials is a high-risk enterprise. Military application requires accelerating commercialization of such materials by reducing risk, and identifying applications in the scale-up and development phases.

COMMERCIAL POTENTIAL: Commercial promise is based on many unique properties that have been exhibited by some researchers on a laboratory scale. Extremely high strength single phase and multiple phase (composite) nanoscale materials should be of interest for lightweight mechanical structures, commercial tools, and coatings. Porous nanoscale structures offer promise as high surface area substrates for chemical catalysts, energy storage/generation devices, pollution abatement systems, and electrically selective ion-exchange membranes. Nanoscale grain size structural materials allow superplastic forming of complex-shaped products from otherwise refractory materials.

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ARPA SB961-013 TITLE: <u>Advanced Systems to Enhance Patient Care at Remote Locations</u>

CATEGORY: 6.2 Exploratory Development; Biomedical Technology

OBJECTIVE: Design and create teleoperator and telemanipulator devices that can provide medical and surgical therapy at remote sites, including the far forward battlefield.

DESCRIPTION: The opportunity exists to create teleoperator devices that can provide remote medical or surgical therapy. The challenges include: 1) solve the "latency" or "lag" problem for long distance teleoperation, 2) highly dexterous telemanipulators which are scalable, 3) tactile displays of high fidelity, 4) incorporation of microsensors into devices to create "smart" manipulators, and 5) design entire remotely-controlled micro-instruments (micro-robots).

PHASE I: Perform the design and early breadboard for a remote manipulator, tactile display, or micro-manipulator.

PHASE II: Create a prototype telemanipulator, tactile display, or micro-robot capable of enabling a therapeutic or diagnostic maneuver at a remote site. There must be compatibility with current generation networks, and it must be intuitive to the operator.

COMMERCIAL POTENTIAL: The development of remote medical and surgical therapeutic devices will create a market for

an entirely new set of diagnostic and therapeutic modalities for the delivery of health care. Current devices could be converted to a new generation of intelligent instruments, expanding the capabilities of existing diagnostic and therapeutic devices.

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ARPA SB961-014 TITLE: Development of Impurity Tolerant Electrocatalysts for Proton Exchange Membrane (PEM) Fuel Cells

CATEGORY: 6.2 Exploratory Development; Electronics, Environmental Quality, Surface/Under Surface Vehicles, Ground Vehicles

OBJECTIVE: Develop efficient, high-activity anode and cathode electrocatalysts for proton exchange membrane (PEM) fuel cells, which are tolerant to impurities in both the fuel and air streams.

DESCRIPTION: Performance improvements in PEM fuel cells have lead to numerous potential applications on the battlefield and in the civilian sector. Despite the use of noble metal catalysts, however, fuel impurities (e.g., sulfur and carbon monoxide which may be intrinsic in the fuel or are by-products of fuel processing) can reversibly poison the anode and decrease performance dramatically. "Scrubbing" the fuel is an expensive and time-consuming process that may limit the ultimate utility of fuel cells. Similarly, pollutants in the air (whether they be smoke, smog, or battlefield contaminants) may degrade cathode performance. Cathode performance may also be lowered in direct methanol oxidation PEM fuel cells by methanol permeating through the proton exchange membrane. Thus, the development of impurity-tolerant electrocatalysts is critical to the deployment of these high-efficiency, quiet, and environmentally sound power systems.

Catalyst development may follow the lead of the chemical processing industry where alloys and/or additives (such as alkali metals or rare earth oxides) are used to improve the impurity tolerance of catalysts. Alternatively, discrete transition metal cluster compounds may prove to be effective electrocatalysts due to their high selectivity toward only the fuel molecule. One can also envision the use of hybrid materials. Finally, there is the potential for both classes of catalysts to oxidize impurities directly, an effective tactic employed at elevated temperatures.

PHASE I: Tests of membrane electrode assemblies incorporating advanced anode and/or cathode electrocatalysts with fuels and/or air with impurity levels at "real world" levels.

PHASE II: Stack tests (>250 W) of optimized electrocatalysts (including >1000 hr life test) on "worst case" fuels and/or air.

COMMERCIAL POTENTIAL: The development of impurity tolerant electrocatalysts will lead to the manufacturing of fuel cells with a longer potential useful life. Balance-of-plant costs will also decrease since extensive fuel and/or air filters/scrubbers will not be required. Finally, the system will be able to operate on lower grade (and therefore lower cost) fuels.

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Appleby and Foukes, *Fuel Cell Handbook,* (Krieger Publishing, 1993).

ARPA SB961-015 TITLE: Magnetic Oxide Films

CATEGORY: 6.1 Basic Research; Materials, Processes and Structures

OBJECTIVE: Prepare high quality films of magnetic oxide materials over large areas and at high yield on technologically useful substrates. These materials must be consistent with applications to magnetic field sensors, as well as other magnetic devices.

DESCRIPTION: Recent discoveries of large magnetoresistive effects in magnetic oxide films points up the need for developing the deposition methods and tools to prepare these films, as well as other technologically useful magnetic oxides, in a consistently high quality form over large areas and with high yield. It is essential that the properties that make these films useful be preserved. The deposition environment must therefore be monitored and controlled.

PHASE I: Demonstrate that the deposition method proposed can be used to prepare the magnetic oxide films with the desired properties.

PHASE II: Demonstrate the conditions necessary to prepare high-quality films over large areas with high yield. This would include the development of the appropriate monitoring, as well as control tools.

COMMERCIAL POTENTIAL: The successful development of these deposition methods will create markets not only for these useful films (which can be used in many sensor, high frequency and precision machining applications), but for the deposition, monitoring, and control methods that make the high quality deposition of these films possible.

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ARPA SB961-016 TITLE: Solid State Growth of Ceramic Single Crystals

CATEGORY: 6.2 Exploratory Development; Sensors, Electronics

OBJECTIVE: Develop a method for the solid state conversion of complex-shaped polycrystalline ceramics to single crystal products.

DESCRIPTION: Functional ceramics are essential to the operation and performance of many high technology products. Optical, magnetic, electronic, ferroelectric, piezoelectric, and elastic properties are tensor properties dependent on crystallographic orientation. While powder processing facilitates the low-cost formation of near-net shape components and cofired structures, such as multilayer substrates and capacitors, the random crystallographic texture obtained by this method may not optimize the performance relative to single crystals. However, manufacturing methods for single crystals are not generally applicable to the low-cost production of complex, near-net shape components. The use of oriented seed grains for secondary grain growth to accomplish the solid state conversion of polycrystalline near-net shape components to either single crystals or highly textured single crystals has the potential to fabricate single crystals at polycrystalline prices and to manufacture unique devices not otherwise manufacturable. Textured aluminum oxide fibers have been fabricated using seed grains of ferric oxide, which are aligned during fiber spinning. Textured cobalt rare earth magnets are fabricated by magnetically aligning large seed grains in the presintered powder compact, which consume the smaller non-aligned grains following densification.

Depending on crystal symmetry, the orientation of one to three crystallographic axes of the seed grains may be needed to self-assemble the random polycrystalline body into a single crystal. Strategies, such as transient solid phase sintering, must be developed to minimize pore entrapment during grain growth if a dense single crystal is required. The synthesis of faceted seed grains, which are alignable in shear flow fields, magnetic field gradients, or electric field gradients, may be useful to achieving the goals of this topic.

Innovative approaches are sought for the low-cost solid state conversion of polycrystalline components to single crystal form. The single crystal component and/or device must be application driven. Relaxor ferroelectric sonar transducers and holographic crystals for memory storage are of particular interest.

PHASE I: Develop low-cost, solid state processes for the conversion of polycrystalline ceramic components to single crystal form. The composition of the chosen material system must have a compelling application enabled by the single crystal or textured form. The processes developed should be scalable and translatable to new systems.

PHASE II: Using the process developed in Phase I, fabricate devices of interest and evaluate the device performance, manufacturing costs, and market potential.

COMMERCIAL POTENTIAL: Solid state methods for the growth of single crystal electroceramics offer the potential for affordable and scaleable manufacture of high value components. Growth markets include sensors, transducers, and electro-optics.

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ARPA SB961-017 TITLE: Quasi-Phasematched (QPM) Non-Linear Frequency Conversion

CATEGORY: 6.2 Exploratory Development; Electronic Warfare

OBJECTIVE: Develop a new class of quasi-phasematched (QPM) non-linear frequency conversion devices in the 2 to 5 μm mid-infrared spectral regions.

DESCRIPTION: Mid-infrared sources in the 2 to 5 μm region, based on QPM non-linear frequency conversion devices, will have broad applications in laser based infrared countermeasures, industrial process monitoring, and atmospheric and environmental monitoring. Recently, periodically-poled lithium niobate QPM non-linear frequency conversion devices have been demonstrated for frequency conversion in the mid-infrared spectral regions. The objective of this effort is to develop a new class of QPM non-linear frequency conversion devices in the 2 to 5 μm spectral region, based on ferroelectric crystals other than periodically-poled lithium niobate. For these devices to be practical, the issues related to fabrication, efficiency, tuning range, damage thresholds and device integration with pump sources must be further developed.

PHASE I: Demonstrate QPM non-linear frequency conversion in the 2 to 5 μm region based on ferroelectric crystals other than periodically-poled lithium niobate, using either diode laser or diode pumped solid state laser pump sources. Identify the critical issues and fabrication methods for high average power operation in both continuous wave and pulsed mode.

PHASE II: Based on the results of Phase I, demonstrate high average power mid-infrared sources in the 2 to 5 μm region and evaluate device performance.

COMMERCIAL POTENTIAL: The development of efficient, tunable, mid-infrared sources will have broad commercial applications in industrial process monitoring, and atmospheric and environmental monitoring.

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ARPA SB961-018 TITLE: Advanced Thermoelectric Materials for Cooling and Power Generation

CATEGORY: 6.2 Exploratory Development; Electronics; Environmental Quality; Materials, Processes and Structures

OBJECTIVE: Develop and demonstrate the application of advanced thermoelectric materials in either cooling or power generation applications of relevance to DoD.

DESCRIPTION: The development of thermoelectric materials with high ZT ($>>1$) may raise the efficiency of thermoelectric cooling devices to above that obtained with chlorofluorocarbon based compressors. This may lead to the production of all solid state, high reliability, low power, low vibration cryocoolers for advanced electronics and detectors, as well as refrigeration units with no pressure vessel, no moving parts, and no acoustic signature (e.g., for submarines). In addition, such materials may be used for thermoelectric power generation from either a fuel based heat source (e.g., furnace or solar radiation) or for exhaust heat recovery. Key to the success of these new devices is the identification, synthesis, and characterization of new materials (or classes of materials), new morphologies (e.g., quantum wells, aerogels, or nanostructured materials), and/or new device structures (e.g., thin films). The temperature range of interest will clearly depend on the ultimate application (e.g. cryocooling, air conditioning, or power generation). However, broadening the optimum temperature range of operation is also important.

PHASE I: Synthesis, characterization, and measurement of the thermal and electrical properties of advanced thermoelectric materials with high ZT ($>>1$).

PHASE II: Continue the optimization and characterization of these new materials and demonstrate their use in a thermoelectric device (e.g. for either cooling or power generation).

COMMERCIAL POTENTIAL: Despite the low efficiency of today's thermoelectric materials, applications include space power, cooled picnic baskets, and photodetectors. The market for these products, as well as for conventional refrigerators, air conditioners, and cooling devices for electronic circuits, will grow substantially as the ZT of new materials increases and the ban on chlorofluorocarbons approaches.

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ARPA SB961-019 TITLE: High Fidelity Sensory Input for Modeling and Simulation of Battlefield Casualties

CATEGORY: 6.2 Exploratory Development; Biomedical Technology

OBJECTIVE: Create a new generation of sensory input devices (e.g., tactile, olfactory, etc.) that will increase the fidelity of simulating combat casualties in the battlefield environment. This includes simulating medical forces for planning and training in the virtual battlefield, as well as individual training on a virtual body with ballistic wounding.

DESCRIPTION: Create new and innovative devices that will increase the fidelity of virtual environments for combat casualty training by simulating senses other than visual and auditory. These devices must be compatible with either the Visible Human data set (available from the National Library of Medicine) and/or with the current generation of battlefield environment utilizing DIS/SIMNET networking. They must be small, portable, unobtrusive and intuitive.

PHASE I: Create the design and breadboard prototype for proof-of-concept.

PHASE II: Deliver an early prototype of the device, demonstratable upon either the Visible Human model or within the DIS/SIMNET environment.

COMMERCIAL POTENTIAL: Medical training is moving into simulators to replace animal models for training in combat casualties. Within the civilian sector, simulators are needed for surgical pre-planning, simulation and training of surgical procedures, image guided therapy, and outcomes prediction. This is an entirely new market, which can be expanded not only into the medical (physician, resident, or medical student) arena, but migrated down as educational tools for college and post-graduate training, as well as general heath care education for grade schools and high schools.

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ARPA SB961-020 TITLE: Growth of New Single Crystal Substrates for Cuprate Superconductors

CATEGORY: 6.2 Exploratory Development; Materials, Processes and Structures

OBJECTIVE: Grow large (>4 inch diameter), very high quality, twin free, low dielectric loss, single crystals of compounds that can be used as substrates for the growth of microwave quality films of the cuprate superconductors.

DESCRIPTION: Until now, most high microwave quality films of yttrium barium copper oxide (YBCO) and other cuprate superconductors have been grown on lanthanum aluminate which has the detrimental quality of forming twins at a temperature below the growth temperature for the cuprates. Recently, compounds like strontium aluminum tantalate and doped lanthanum aluminate have been found to have the desired qualities, but large single crystals have not yet been demonstrated.

PHASE I: Demonstrate the growth of new improved substrate materials with the desired properties that will provide for the growth of microwave quality cuprate films.

PHASE II: Scale up the growth of high quality crystals to a size which is consistent with the needs of the superconducting device community (2-4 inch diameter).

COMMERCIAL POTENTIAL: The successful development of these substrates will not only create markets for these substrates, which can be substantial, but will significantly benefit the fledgling superconducting device community by significantly improving the reproducibility of its devices. The superconducting films can be used in many applications to wireless communications, radar and electronic warfare.

REFERENCES:

IEEE Transactions on Applied Superconductivity, 5, No. 2, 1995, pg. 3203.

ARPA SB961-021 TITLE: On-Chip Microfluidics for Integrated BioAnalysis Systems

CATEGORY: 6.2 Exploratory Development; Chemical and Biological Defense

OBJECTIVE: Develop reliable on-chip microfluidic components for integrated analysis systems involving biological fluid flow.

DESCRIPTION: There are many potential advantages for applying Micro-Electro-Mechanical Systems (MEMS) technology to the challenge of achieving rapid, accurate, and affordable analysis of biological molecules, agents, and toxins. Using MEMS to store and manipulate biological fluids, however, represents a significant departure from non-biological MEMS because of the need for devices and structures to come into routine contact with aqueous solutions that may contain corrosive salts or materials that tend to absorb and aggregate on surfaces. Requirements of this topic are to develop novel MEMS-based structures, sensors, and actuators or to modify existing structures, sensors, and actuators, in order to achieve reliable and well-characterized on-chip flow of biological fluids. Proposers may submit concepts for systems that achieve integrated transport, detection, and identification of a specific bioagent or group of bioagents, using novel micro-fluidics techniques, or concepts for novel technologies, including, but not limited to, specific 3-D microfabrication or surface modification technologies, to allow the tailored modification of physical surfaces with which biological fluids are likely to come into contact in miniaturized fluidic structures.

PHASE I: Identify a technology or combination of technologies to achieve reliable and biocompatible on-chip storage and transport of biological fluids. Outline current maturity of the proposed technology. Identify and analyze the major problem areas associated with this technology. Produce a development plan which addresses the approach to solving key technology issues. Identify quantitative goals for system performance. Provide evidence that the scientific principles on which the proposed technology is based are sound, and justify further work. Develop a Phase II plan and schedule that identifies the work necessary to demonstrate technical feasibility and to increase the potential of the technology to transition to Defense and private-sector applications.

PHASE II: Develop and demonstrate Phase I systems/technologies. Explore critical parameters and optimize the design. Document work performed. Provide in-depth performance evaluation and an analysis of the potential for further integration and miniaturization of the technology.

COMMERCIAL POTENTIAL: This technology applies to medical diagnostics and environmental protection product markets.

REFERENCES:

1) Proceedings of the 1994 Solid-State Sensor and Actuator Workshop, Hilton Head Island, SC, June 13-16, 1994.

2) Stenger, D.A., and McKenna, T.M. (eds.), Enabling Technologies For Cultural Neural Networks, San Diego, CA: Academic Press: 1994.

3) Sze, S.M. (ed.), Semiconductor Sensors, New York, NY: John Wiley & Sons, Inc.,1994.

ARPA SB961-022 Title: Electronic Systems Manufacturing (ESM)

CATEGORY: 6.2 Exploratory Development; Electronics, Manufacturing Science and Technology, Modeling and Simulation

OBJECTIVE: Develop manufacturing and associated technologies that enable on-demand, volume-independent, but scalable, high yield production of electronic systems, subsystems, and modules.

DESCRIPTION: Electronic systems and subsystems represent about 40% of the Defense acquisition budget and are the critical enabling technology that differentiates our weapon systems. As the DoD downsizes, it will become increasingly important to be able to leverage the merchant contract manufacturing infrastructure for economies of scale to reduce unit production costs. The objectives of the Electronic Systems Manufacturing (ESM) program are to put in place a capability that concurrently provides both quick reaction, rapid prototyping and cost-effective volume production when needed. Technologies necessary to achieve this goal include: 1) integrated 3-D CAD and analysis tools to support the error-free electrical/mechanical/thermal design of printed wiring assemblies and subsystems, 2) software systems to support paperless data exchange from design to the manufacturing floor, 3) simplified manufacturing processes to reduce costs, and 4) electronic brokering technologies to shorten lead times for discrete components and printed wiring boards. This effort is seeking innovative software tools, and flexible manufacturing equipment and processes to support the ESM objectives. Efforts may address any topical area that supports ESM

objectives, however, the four areas identified above are of particular interest. Proposals should clearly identify the areas of greatest impact and quantify the anticipated results.

PHASE I: In detail, define and validate the approach to developing technologies for rapid prototyping and/or production techniques as applied to merchant, contract electronics manufacturing and assembly. For software tools, provide requirements definition and prototype critical functionality, as appropriate. For manufacturing equipment and processes, unambiguously quantify benefits of approach with preliminary experiments, prototypes, or simulations, as appropriate.

PHASE II: Implement the plans developed under Phase I. For software tools, complete core functionality with appropriate documentation, then validate operation and utility. For manufacturing equipment and processes, complete detailed experimental series and demonstrate new capabilities on prototype tool.

COMMERCIAL POTENTIAL: The world electronics system market is now about $700 billion and is forecasted to exceed $1 trillion by the end of the decade. Technologies that lead to improvements and cost-reductions in electronics manufacturing will have great commercial potential.

REFERENCES:
1) "Electronics Manufacturing Technology Roadmaps and Options for Government Action," prepared by the National Electronics Manufacturing Framework Committee (1994).
2) "The National Technology Roadmap for Electronic Interconnections," pub. by The Institute for Interconnecting and Packaging Electronic Circuits (IPC), (1995).
Additional and related information available on World Wide Web at:
http://eto.sysplan.com/ETO
http://esc.sysplan.com/ESC/

ARPA SB961-023 TITLE: Development of Low-Cost, Hand-Held Displays Utilizing Microelectromechanical Devices

CATEGORY: 6.2 Exploratory Development; Command, Control and Communications; Electronics

OBJECTIVE: Demonstrate novel display technology, based on microelectromechanical devices capable of rugged, low-power operation and high resolution, suitable for portable information tools.

DESCRIPTION: High image quality, low-power consumption displays are needed for lightweight, hand-held information terminals. The military has specific requirements for wide operational temperature range, ruggedness, and high contrast in full sunlight ambient. Several new concepts are being developed which utilize microelectromechanical (MEM) devices as shutters, light guides, or reflective surfaces to provide high resolution display imagery. Previous concepts have developed large screen projection displays based on micromirror devices, however, these devices have limited utility for hand-held applications. This topic is seeking to explore new concepts and develop prototype demonstrations using integrated electronic and MEM devices for displays suited to low power, portable, hand-held displays such as found in today's personal digital assistants.

PHASE I: This phase is intended to be a design characterization of new display architectures and must address fabrication plans and costs, resolution, color capability and greyscale, as well as system power requirements. Preliminary experimental characterization of concepts during Phase I is desirable.

PHASE II: This phase will involve the fabrication and characterization of an operational test device to demonstrate the suitability of this display architecture for use in a portable, rugged, hand-held display device.

COMMERCIAL POTENTIAL: The development of such a display technology will be well-suited to a variety of military and commercial needs. For commercial applications, low-power, high resolution displays are needed in applications, such as personal digital assistants, and today's conventional solutions leave much to be desired in terms of resolution and color/grey-scale capability.

REFERENCES:
Society for Information Display International Symposium, Digest of Technical Papers, Jay Morreale, Editor, Vol. XXVI (1995).
Additional and related information available on World Wide Web at:
http://eto.sysplan.com/ETO/ (see High Definition Systems and MEMS Programs)

ARPA SB961-024 TITLE: Wide-Temperature Liquid Crystal Materials and Cells for Reflective Displays

CATEGORY: 6.2 Exploratory Development; Command, Control and Communications; Electronics

OBJECTIVE: Demonstrate reflective liquid crystal device technology with clear potential for obtaining all of the following simultaneously: -30° C to +50° C operating range, 20:1 contrast in outdoor ambient, video-rate response, full color, 40% white diffuse reflectivity and passive matrix addressable to million pixel counts.

DESCRIPTION: High image quality, low power consumption flat panel displays are needed for lightweight, hand-held information terminals. The military has a specific need for displays which have low power consumption, high contrast in a full sunlight ambient, and which operate satisfactorily over a wide temperature range. Reflective liquid crystal displays are attractive because they generally have low power consumption. Current reflective liquid crystal displays have shortcomings in one or more of the following: operational temperature range, contrast, response time, reflectivity, ability to display full color, bistability and switching voltage (which translates to high-cost).

PHASE I: Identify promising liquid crystal materials and/or cell structures which offer significant advantages over currently known reflective liquid crystal display types, such as twisted nematic and super-twisted-nematic, stabilized cholesteric, polymer dispersed, and surface stabilized ferroelectric. Fabricate single pixel cells and demonstrate the potential advantages of the new concept(s) by measuring relevant characteristics such as the following: reflectivity and response time vs. voltage, temperature effects on contrast and response time, contrast under controlled lighting conditions, specular and diffuse reflectivity, and capacitance and bistable behavior (if applicable).

PHASE II: Demonstrate and deliver a prototype monochrome reflective display (e.g., 7.5 cm x 10 cm, 320 column x 240 row) based on the Phase I concept which demonstrates wide temperature range, and high-contrast in outdoor ambient and video-rate response. Determine potential for obtaining color using this technology.

COMMERCIAL POTENTIAL: High contrast, wide temperature, reflective liquid crystal displays are in demand for a broad range of outdoor-use products, including laptop computers, pagers, personal digital assistants, and portable telephones.

REFERENCES:

Society for Information Display International Symposium, Digest of Technical Papers, Jay Morreale, Editor, Vol. XXVI (1995)
Additional and related information available on World Wide Web at:
http://eto.sysplan.com/ETO/ (See High Definition Systems)

ARPA SB961-025 TITLE: Efficient Inorganic Light Emitting Device Technology for Portable Emissive Displays

CATEGORY: 6.2 Exploratory Development; Command, Control and Communications; Electronics

OBJECTIVE: Demonstrate a power-efficient and reliable inorganic electroluminescent display technology compatible with plastic substrates.

DESCRIPTION: High image quality, low-power consumption flat panel displays are needed for lightweight, hand-held information terminals. The military has a specific need for displays which have low-power consumption and are reliable, very thin, rugged, and lightweight. Conventional thin film alternating-current electroluminescent displays are power inefficient, use relatively bulky power supply electronics, high-cost, high-voltage driver chips, and cannot be fabricated using unbreakable plastic substrates. Organic direct-current electroluminescent displays use lower drive voltages and can be made using plastic substrates, but are not sufficiently reliable for demanding applications.

PHASE I: Demonstrate low voltage inorganic electroluminescent device concept that is compatible with plastic substrates and that promises good reliability and power efficiency (greater than 1 lumen/watt). Assess potential for obtaining greater than 1 lumen per watt, red/green/blue color and competitive manufacturing cost.

PHASE II: Demonstrate and characterize a multi-pixel, monochrome, electroluminescent display which uses a plastic substrate and evaluate suitability for hand-held display system applications.

COMMERCIAL POTENTIAL: Power-efficient, lightweight, emissive flat panel displays would be useful for a broad range of electronics products, including laptop computers, pagers, personal digital assistants, and portable telephones.

REFERENCES:

Society for Information Display International Symposium, Digest of Technical Papers, Jay Morreale, Editor, Vol. XXVI (1995).
Additional and related information available on World Wide Web at:
http://eto.sysplan.com/ETO/ (See High Definition Systems)

ARPA SB961-026 TITLE: Energy Scavenging for Small Data Collection Systems

CATEGORY: 6.2 Exploratory Development; Surface/Undersurface Vehicles

OBJECTIVE: Develop and demonstrate small power supply systems that scavenge energy from the environment to power long-endurance data collection devices.

DESCRIPTION: Small power supply systems that scavenge energy from the environment are needed for various types of long-endurance data collection devices. This type of power supply would be used for data collection systems which require a combination of endurance and small package size not achievable using batteries alone, or for systems in locations that make battery replacement difficult or impractical. For the applications envisioned, the size of the power system require ranges from integrated circuit size to approximately one cubic foot. Applications for this type of power supply include systems that operate on land, underwater, or on the water surface. Land systems may be stationary or attached to a moving vehicle. Maritime systems may be free floating, resting on the bottom, moored, or attached to a moving vessel. Energy sources could include wind, ambient light, temperature differences and changes, vibration, accelerations, sound, ambient RF fields, pressure changes, water waves, and water flow. It is expected that power scavenging systems will require an energy storage unit to provide higher power on an intermittent basis for communications, or for energy, when the environmental source is unavailable. In addition, a low-power control system may be required to regulate power to the data collection system, and control power to and from the storage unit. Primary interest is in novel energy scavenging systems, as opposed to packaging of conventional devices, such as solar cells.

A militarily significant data collection task should be selected to demonstrate energy scavenging. Energy scavenging should make it possible to increase the endurance or decrease the size of the data collection system for the task selected. Example tasks include tagging of vehicles, cargo and weapons; land and maritime surveillance; and the collection of meteorological or oceanographic data. Although data retrieval could be accomplished by recovering the device and accessing stored information, a data collection system that can communicate collected data is necessary for some tasks and preferred for most tasks.

PHASE I: For the selected task(s), assess the power requirements, and develop and demonstrate novel energy scavenging devices. Determine, through measurement and modeling, the power available under various conditions.

PHASE II: Using the results of Phase I, design and build a complete energy scavenging and storage system for the selected task(s). The performance of the complete system should be demonstrated and evaluated in selected environments.

COMMERCIAL POTENTIAL: The development of energy scavenging systems will have broad commercial applications, including the development of long endurance, data collection systems that require no maintenance. Applications include the detection of chemical effluents, tracking of cargo, shipboard hazard sensing, security alarm systems, collection of scientific data, and distributed meteorological sensing for more accurate weather prediction.

REFERENCES:

Smith, Norman F., "Energy Isn't Easy," Coward-McCann, Inc. , 1984

ARPA SB961-027 TITLE: Magneto-Rheological (MR) Fluids, Devices, and Applications

CATEGORY: 6.2 Exploratory Development; Materials, Processes and Structures

OBJECTIVE: Develop new Magneto-Rheological (MR) fluids with enhanced performance; develop design concepts for hydraulic system components, actuators, valves, and dampers that take advantage of MR properties to reduce size and weight while extending performance beyond the limits of passive fluids; and develop manufacturing techniques to reduce the cost of MR fluids.

DESCRIPTION: MR fluids are liquids containing a suspension of ferric particles whose effective viscosity can be changed by the application of a magnetic field. These fluids have the potential to revolutionize the design of hydraulic systems, actuators,

valves, active shock and vibration dampers, and other components used in military mechanical systems. At present, MR fluids are not readily available in production volumes or quality. The fluids that are available are expensive and suffer from problems with settling out of the suspended particles, and limited shear stress vs. magnetic field strength performance. Because of the relative scarcity of suitable fluids, little work has been done in development of devices that exploit the "smart materials" property of MR fluids. Efforts of interest include development of new fluids, development of application devices, and development of manufacturing processes that will reduce the cost of MR fluids.

PHASE I: Produce laboratory quantities of new fluids and measure their engineering properties; or design, fabricate, and test prototype devices that exploit MR fluid active properties; or design and implement laboratory scale processes for MR fluid manufacture.

PHASE II: Design and implement pilot scale processes for MR fluid manufacture, and produce system level quantities of new fluids; or design, fabricate, and test prototype systems that exploit MR fluidic devices.

COMMERCIAL POTENTIAL: MR fluids and devices have the potential to revolutionize the design of hydraulic systems, actuators, valves, active shock and vibration dampers and other components used in commercial mechanical systems, such as vehicle suspensions, machine tools, aircraft vibration isolation, etc. They have the potential for a dramatic improvement in the performance of such systems at reduced cost, and offer secondary gains through the reduced weight of hydraulic systems and structural actuators in commercial aviation and aerospace applications.

REFERENCES:

1) G. Bossis and E. Lemaire, "Yield Stresses in Magnetic Suspensions," J. Rheol. 35, p. 1345 (1991).
2) T. Fujita, J. Moshizuki and I. J. Lin, "Viscosity of Electrorheological Magneto-Dielectric Fluid Under Electric and Magnetic Fields," J. Magn. Magn. Mat. 122, p. 29 (1993).
3) J. M. Ginder and L. C. Davis, "Shear Stresses in Magnetorheological Fluids: Role of Magnetic Saturation" Appl. Phys. Lett. 65, p. 3410 (1994).
4) D. J. Klingenberg, "Making Fluids Into Solids With Magnets," Sci. American , p. 112 (1993).
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6) W. I. Kordonsky, "Magnetorheological Effect as a Base of New Devices and Technologies," J. Magn. Magn. Mat. 122, p. 395 (1993a).
7) W. I. Kordonsky, "Elements and Devices Based on Magnetorheological Effect," J. Intel. Mat. Sys. Struct. 4, p. 65 (1993b).
8) E. Lemaire, G. Bossis, and Y. Grasselli, "Yield Stress and Structuration in Magnetorheological Suspensions," J. Magn. Magn. Mat. 122, p. 51 (1993).
9) Z. P. Shulman, V. I. Kordonsky, E. A. Zaltsgendler, I. V. Prokhorov, B. M. Khusid and S. A. Demchuk, "Structure, Physical Properties and Dynamics of Magnetorheological Suspensions," J. Magn. Magn. Mat. 12, p. 935 (1986g).
10) M. Whittle and W. A. Bullough, "The Structure of Smart Fluids," Nature 358, p. 373 (1992).

ARPA SB961-028 TITLE: Optical Network Switching Technology

CATEGORY: 6.2 Exploratory Development; Command, Control and Communications; Electronics (Optoelectronics)

OBJECTIVE: Develop and demonstrate optical network switching technology that permits the routing of optical signals in a way that does not require the conversion of the signal from optical to electrical format.

DESCRIPTION: Research and develop optical network switching technology that permits the routing of optical signals in a way that does not require the conversion of the signal from optical to electrical format. Signal-header conversion and electronic control of the switching fabric is envisioned as the means for setting the switch, and methods of achieving high speed switching are of greatest interest. Applications include optical cross-bar, wavelength selective and very short pulse switching. Candidate optical switching technologies include electrically-controlled refractive index changes in thin film or fiber waveguides formed with electro-optically active materials, semiconductor amplifier switches, liquid crystal shutters combined with spatial or wavelength selective elements, and acousto-optically tuned filters. Performance goals should be targeted to meet the requirements for emerging optical networks operating at 2.5 Gb/s or higher, and to accommodate both digital and analog signal formats. Monolithic and hybrid integrated approaches leading to compact modules, designed to provide good cross-talk suppression, will be considered.

PHASE I: Develop a proof-of-concept switch design, either through fabrication of critical switching component prototypes, or by detailed modeling of switch design based on the demonstrated performance of existing components.

PHASE II: Develop and demonstrate a fully functional switch module capable of demonstrating critical functionality, and provide design documentation for full-scale switch development.

COMMERCIAL POTENTIAL: The development of efficient optical switching technologies will expand the commercial markets for data communication systems by enabling the application of broadband optical communication techniques to small (LAN, WAN) private networks. Compatibility with multiple signal formats will greatly enhance the capability to efficiently network diverse sources of information and stimulate the development of information superhighway applications while also accelerating the introduction of state-of-the-art facilities designed to meet DoD communication needs.

REFERENCES:

1) Technical Digest-Photonics in Switching Meeting; 1995 Technical Digest Series Volume 12, Optical Society of America,(1995).
2) Photonics in Switching Vol I & II, J. E. Midwinter ed., Academic Press Inc., (1993).

ARPA SB961-029 TITLE: Materials and Process Technologies for Low-Power Semiconductor Circuits

CATEGORY: 6.2 Exploratory Development; Electronics; Materials, Processes and Structures; Manufacturing Science and Technology

OBJECTIVE: Develop viable alternate semiconductor substrate materials, tools, processes, and associated integration technologies that enable leading-edge, low-power, microelectronic device and circuit fabrication.

DESCRIPTION: Advances in integrated circuit (IC) manufacturing and innovations in design technologies are leading to new generations of wireless, portable information technology products and components. The capabilities of these new electronic systems include completely integrated functionality, embedded signal processing, high-speed data-processing, and high bandwidth communication channels. However, the cost-effective limitations of practical battery sources and thermal mitigation approaches are being reached since the high computational capabilities and data throughput of leading-edge ICs have also led to a marked increase in the electrical power dissipation. System size and weight, along with functionality and cost, are among the factors that differentiate these microelectronics systems. Additionally, in some cases, the spatial volume occupied by the microelectronics and associated support systems (i.e., power supplies, thermal mitigation, racks, etc.) is of a critical concern. Substantial reductions in the power dissipated by electronics will allow electronic systems to potentially utilize smaller volume batteries with longer useful lifetimes, reduce packaging costs, eliminate heat sinks and other thermal mitigation systems, and enable reductions in the capacities and quantities of external power supplies. Approaches that allow power supply reductions to the range of 0.9-1.2V are of particular interest. However, simply reducing the power supply voltage may also reduce the device operation speed, affecting performance. The objectives of this effort are to develop leading-edge semiconductor technologies that enable a significant reduction in power dissipation as compared to conventional technologies or approaches with minimal penalty to performance or functionality. Among the possible technology areas of interest are: ultra-shallow junction formation, thin-film silicon-on-insulator (SOI) substrate technologies, first-principles simulation models to couple alternate material and process manufacturing parameters to device and circuit metrics, and new approaches to process integration that incorporate low-power unit processes.

PHASE I: Provide a detailed technical approach that fully describes the specific technology approach and the anticipated benefits. Fully quantify the expected costs and impact on wafer flow. As appropriate, perform computer simulations, initial experiments, or provide detailed design of experiments to verify technology approach. As appropriate, provide plans on transitioning equipment/process technology to widest use in industry.

PHASE II: Implement the plans developed in Phase I to develop materials tools, processes, or other approaches. Complete experiments to validate equipment and process approach. For materials, demonstrate capabilities to produce sufficient quantities of high quality substrates.

COMMERCIAL POTENTIAL: Low-power electronics is an area of great interest to commercial semiconductor and system OEMs. Materials, processes, tools, or other approaches that allow reduced electronic power dissipation, without impacting performance, have tremendous application to merchant fabrication lines and will be incorporated rapidly in their operation.

REFERENCES:

1) "The National Technology Roadmap for Semiconductors," published by the Semiconductor Industry Association (1994).

2) "Silicon-on-Insulator Technology: Materials to VLSI," J.P. Collinge, Kluwer Academic Publishers, Hingham, MA, USA, (1991).
3) Also see recent proceedings from conference or symposia, such as:
IEEE Low Power Symposium
IEEE International SOI Conference
Proceedings of the ElectroChemical Society Meetings, Silicon Wafer Bonding: Technology and Applications, most recently held in May 1995 in Reno, NV.

ARPA SB961-030 TITLE: Maskless Lithography for Microelectronic Devices with Features of 0.1 Microns

CATEGORY: 6.2 Exploratory Development; Electronics

OBJECTIVE: Demonstrate subsystems for a tool enabling, cost-effective fabrication of microcircuits with 0.1 micron design rules.

DESCRIPTION: The fabrication of future advanced semiconductor devices will require the patterning of small features (0.10 microns and below) on the semiconductor wafer. Maskless writing of these features has long been a goal, but the application has been limited by slow writing times. A variety of approaches can potentially solve the throughput issue while meeting the requirements for pattern placement and dimensional control. These include recent advances in electron sources and optics, data path electronics, and stage control, which can be combined to provide a suitable combination of number of beams, current levels and uniformity, switching speeds, and reliability. New approaches that will address these key issues are being sought. In addition, alternative lithography technology approaches that can meet the goals of maskless 0.1 micron feature resolution with sufficient overlay, depth of focus, and wafer throughput, will also be considered. All approaches will be evaluated for effectiveness when implemented into future wafer writers. A path to eventual implementation through a commercial product must be outlined.

PHASE I: Fully define the approach, outline the detailed design, and begin initial experimentation that will provide the required improvement.

PHASE II: Develop and build a breadboard unit to demonstrate successful achievement of the goals. Provide a detailed plan for implementation into tooling commercially available to the industry.

COMMERCIAL POTENTIAL: The development of maskless lithography would be of significant value to the commercial integrated circuits industry, which has world sales of about \$100B in 1995. This tool would be particularly useful for circuits with low manufacturing volume, eliminating the need for the expensive mask tooling which is unique with each circuit design. Furthermore, during the development phase for circuits with high volume applications, it would reduce the time to market and eliminate the mask tooling cost necessitated by design changes during development.

REFERENCES:
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2) "Applications of a High Throughput Electron Beam System for 0.3 micron Large Scale Integration," F. Mizuno et al, J. Vac. Sci. Tech. B12, 3440 (Nov/Dec 1994).
3) "Fast Electron Beam Lithography System with 1024 Beams Individually Controlled by a Blanking Aperture," S. Arai et al, J. Jap. Appl. Phys., 32, 6012 (1993).
4) "Negative Electron Affinity Cathodes as High Performance Electron Sources," A. W. Baum, K. Costello, V. Aebi, W.E. Spicer, R.F.W. Pease, SPIE Symposium, July 1995, San Diego, CA,papers 2522A-18 and 2550-7.
5) "High Speed Electron Beam Testing Using GaAs Negative Electron Affinity Photocathodes," C.A. Sanford, N.C. MacDonald, Microelectronics Engineering, 12, 213-220 (May 1990).

ARPA SB961-031 TITLE: Virtual Prototyping Tools for Semiconductor Fabrication Equipment

CATEGORY: 6.2 Exploratory Development; Electronics; Materials, Processes and Structures; Manufacturing Science and Technology

OBJECTIVE: Develop a new class of integrated design tools to improve the design and implementation of advanced semiconductor manufacturing processes. These tools will enable physics-based modeling and simulation of semiconductor

manufacturing equipment to predictively determine such characteristics as process response surfaces, process performance, particulate generation, and process space stability and controllability, prior to physical prototyping of the tool.

DESCRIPTION: The development of advanced semiconductor manufacturing tools, such as chemical vapor deposition (CVD) reactors, rapid thermal processors, etch systems, and lithography exposure tools are complex, multi-disciplinary tasks. While some computer aided design (CAD) tools have been employed to design mechanical components in these systems, the full potential for utilizing computer modeling and simulation tools to simplify and improve the equipment development process has yet to be fully exploited. Computer simulation tools, which account for first principle process reactions, are needed to model particle transport, plasma dynamics, heat transfer in the processing chamber, turbulence and chemical interactions in the gas flow and on the surface of the wafer, mechanical reliability of the wafer handling system, and the behavior of the control system. These software tools and models could be used to predictively develop unit processes and simplify tool integration. The same compact models used to design the tools might also be employed during tool operation to enable "intelligent" semiconductor processing, where the tool control system can itself determine and control the proper process variables to achieve a desired process characteristic (e.g., 3nm gate oxide). Although, some of these tools exist in the university community, few are available commercially or are widely used in the semiconductor manufacturing equipment industry. Furthermore, integration between different tools and links to technology-CAD frameworks and tools may be necessary to support systems level simulation and provide mappings between physical processes (i.e., particle transport) and material growth, and etch rates and profiles at appropriate spatial and temporal scales. Widespread use of such tools and tool frameworks would greatly reduce the development and lifecycle cost of new manufacturing tools by allowing the tool's designers to rapidly try out a number of alternative configurations without having to physically prototype the systems. The focus of this effort is to develop the core functionality of the software tools that enable virtual prototyping of semiconductor equipment.

PHASE I: Define a detailed specification of the proposed tool or environment that supports modeling and simulation of a class of semiconductor manufacturing tools. In detail, describe new or novel ideas or algorithms that will provide new modeling and simulation capabilities as they relate to equipment design. Develop a plan to validate the functionality and utility of the tool in the design or improvement of a semiconductor manufacturing tool.

PHASE II: Implement the tool or prototype environment defined in Phase I and demonstrate its utility in the development of some piece of semiconductor manufacturing equipment. Demonstrate core functionality of the software tools in relevant design problems.

COMMERCIAL POTENTIAL: The software tools and methods developed under this effort will have direct application to commercially available semiconductor manufacturing tools. The goals of this SBIR are to develop and industrialize software tools and design methodologies that enable equipment companies to better design, develop, and maintain high quality manufacturing tools by providing them with access to powerful, sophisticated modeling techniques. The codes themselves will allow equipment developers to accelerate development cycles and reduce costs through elimination of some physical prototyping. There is both primary and secondary commercial potential in the results of this effort, first from the software tools and licenses themselves, then from the improved design approach and novel equipment that results from using the developed codes and techniques.

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ARPA SB961-032 TITLE: <u>Low-Noise Optical Amplifier</u>

CATEGORY: 6.2 Exploratory Development; Electronics; Command, Control and Communications

OBJECTIVE: Develop a low-noise, high-gain integrated optical amplifier for analog radio frequency (RF) photonic systems.

DESCRIPTION: Current optical amplifiers have been designed for digital optoelectronic systems, where noise is not a major consideration, or for digital optical networks, where size is not a major consideration. Analog RF photonic systems require ultra low-noise operation. Compact size is important to maintain small system size. Military systems influenced include antenna systems, RF receivers, satellite communications, and electronic warfare (EW) systems. Optical wavelength of 1.3 microns is

of interest. Optical gains of at least 10 dB optical are of interest. Designs must be power efficient, i.e., maximize electrical power to optical gain. Noise comparable to high-power, low relative intensity noise (RIN) optical sources are of interest, i.e., noise power spectral densities of less than minus 165 dB per Hertz. Low distortion operation is of paramount importance.

PHASE I: Analyze and tradeoff low-noise, high-gain amplifier designs with possible limited breadboarding.

PHASE II: Fabricate a low-noise, high-gain amplifier, evaluate performance experimentally, and integrate the amplifier into a compact package.

COMMERCIAL POTENTIAL: The development of a low-noise, efficient, optical amplifier will have direct benefit to commercial RF photonics systems by enabling high performance operation. Satellite receiver systems for distribution of RF signals over large distances, with improved signal quality, will be made possible. Cellular radio systems will benefit by antenna remoting of the cells by high signal quality, low-loss RF photonics, without the need for complicated and expensive digital processing equipment. Local Area Networks for low distortion distribution of RF signals in large building complexes, aircraft and television network systems will be made possible.

REFERENCES:
1) N. Anders Olsson, "Semiconductor Optical Amplifiers," Proceedings of the IEEE, vol. 80, number 3; 375(1992).
2) E. Desurvire, J.L. Zyskind, and C. Randy Giles, "Design Optimization for Efficient Erbium-Doped Fiber Amplifiers," Journal of Lightwave Technology, vol. 8, number 11; 1730(1990).

ARPA SB961-033 TITLE: Development of Techniques to Ruggedize Graded Index Communication Grade Plastic Optical Fiber

CATEGORY: 6.2 Exploratory Development; Command, Control and Communications; Computing and Software; Electronics

OBJECTIVE: Develop and demonstrate technology to ruggedize graded index communication grade plastic optical fibers, or develop and demonstrate rapid optical coating technology which will protect the plastic optical fiber from temperatures of -40 degrees C to +150 degrees C and moisture ingress, and which are tolerant to low earth orbit radiation.

DESCRIPTION: Recent developments in graded index plastic optical fiber have enhanced the bandwidth of the fiber by a factor of 100 over conventional step index fiber. This new development promises to have a major impact on future interconnect dominated military platforms, as well as commercial data communication and fiber to the home. However, for the full potential of this technology to be realized, an environmentally more rugged fiber needs to be developed. This program is focused on the development of more rugged plastic optical fiber by either the development of protective coating or the development of higher glass transition temperature core/cladding plastic fiber.

PHASE I: Research and develop ruggedized graded index plastic optical fiber (with losses of <300dB/km and bandwidth >2GHz/km) which will withstand temperature ranges of -40 degrees C to +150 degrees C, humidity, and radiation (long term low earth orbit). Preliminary experimental concept demonstration of the capability of either the plastic fiber, or of the coating technology to withstand these environmental constraints.

PHASE II: Extension of the techniques developed in Phase I to develop and demonstrate a viable: a) core/cladding technology, or b) rapid protective coating technology, for the graded index communication grade plastic optical fiber in order to produce the ruggedized plastic optical fiber in limited prototype production. It is important to demonstrate the potential of the approach to scale-up to full-scale production.

COMMERCIAL POTENTIAL: Ruggedized plastic optical fiber would have major commercial significance in computer data communication, local area networks, fiber to the home (the last mile), commercial avionics, as well as lowering the weight and providing Electro-Magnetic Interference (EMI) immunity in future automobile wire harnesses applications. Plastic optical fiber has started being explored for these commercial applications, but the exploitation of the technology has been limited, as the plastic optical fiber is not sufficiently rugged. Overcoming the current environmental limitations of plastic optical fiber would have dramatic impact on many future interconnect dominated, short distance commercial applications as well as military platforms.

REFERENCES:
Society of Photo-Optical Instruments Engineering, Special Issue on Plastic Optical Fiber, (1993).

ARPA SB961-034 TITLE: Miniature Environmental Air Sampler for Biological Materials into Fluid

CATEGORY: 6.1 Basic Research; Chemical and Biological Defense, Sensors

OBJECTIVE: Preliminary design and construction of an efficient and effective air sampling device into a fluid phase that will function in an unattended miniature biological detector system. The efforts may address any new engineering designs.

DESCRIPTION: Biological detectors have the capability of detecting small numbers of bacteria/viruses and toxin molecules. However, the introduction of the sample is currently performed manually. This effort requires the solution of a major engineering problem: the automation of sampling air containing bacteria/virus and toxins into a fluid phase for a miniaturized detection system. This sampling module is a critical component in the development of unattended miniature biological sensors. The efforts may address any new miniature engineering designs that will enable efficient sampling of small amounts of air ranging from 1-2 ml of air or 5-10 ml of air, in as short a time period as possible, creating the smallest sampling systems, consuming the lowest possible power.

PHASE I: An engineering analysis feasibility and design study which will present several design possibilities for miniaturized air to fluid samplers that could be down-selected, constructed, and tested as prototype(s) in Phase II.

PHASE II: Detailed design and construction of an efficient and effective miniature air to fluid sampling module that will function in a miniature biological detector system.

COMMERCIAL POTENTIAL: The development of miniature air-fluid sampling systems will expand the commercial markets for environmental monitors for sick buildings, for medical infectious disease environments, and for agricultural storage facilities.

REFERENCES:

Journal of Aerosol Science, Vol 25, No 8 (1994).

ARPA SB961-035 TITLE: Detection and Characterization of Underground Facilities (UGF)

CATEGORY: 6.2 Exploratory Development; Chemical and Biological Defense, Computing and Software, Environmental Quality, Modeling and Simulation

OBJECTIVE: Develop and integrate innovative algorithms and systems for detecting and characterizing the existence, operation, and prosecution of underground facilities (UGF) based on signal processing and fusion of data collected from local or remote geophysical and environmental sensors.

DESCRIPTION: The problem is to provide rapid and accurate assessments, including the location of sensors, imaging of the geophysical and environmental conditions in the vicinity of the UGF, imaging of the UGF structure, characterization of activity therein, battle damage assessment (e.g., locating and characterizing weapons detonated against UGFs, and of post-attack UGF activity), and collateral damage due to the release of hazardous materials (e.g., biological, chemical and nuclear materials) during and after attack. To address these problems, efforts will explore phenomenology, automated signal processing, automated physics-driven data fusion, visualization, physical modeling and simulation, process modeling, and decision analysis. Input data will come from diverse sensor types, including acoustic, seismic, electromagnetic, optical, chemical, biological and nuclear, meteorological, positioning, etc. The output assessments will be multi-tiered, providing the actionable information necessary for analyst- to commander-level users.

PHASE I: Design the algorithms or systems, and develop a model or proof-of-concept prototype of key elements of the proposed design to demonstrate the anticipated advantages of the proposed approach for providing rapid and accurate assessments of relevant data to one or more of the problems described above.

PHASE II: Develop, demonstrate, and document a full prototype that applies the approach.

COMMERCIAL POTENTIAL: This kind of geophysical and environmental analyses, and fusion of multiple types of sensors has application in petrochemical and mineral exploration, environmental and meteorological monitoring, and security surveillance.

REFERENCES:

"Tactical Multi-Sensor Fusion for Detection and Characterization of Underground Facilities," viewgraphs, May 1995. A copy of these viewgraphs may be obtained by calling (703) 696-2448.

ARPA SB961-036 TITLE: Small Chemical and Biological Agent Sensors

CATEGORY: 6.2 Exploratory Development; Chemical and Biological Defense, Sensors

OBJECTIVE: Develop advanced, spectral-based techniques for the rapid detection and identification of target materials (vapors and aerosols), including chemical and biological agents on the battlefield, that can be used in airborne and ground missions.

DESCRIPTION: A number of advanced technologies are emerging which show potential for mitigating the proliferation of chemical and biological weapons. They promise to resolve previously encountered technology problems. These novel technologies include:

- compact, ultrasensitive, electro-optical techniques, such as 3-D laser doppler velocimeter, heterodyne detection, pseudo-random-noise pulse coding, three-dimensional spatial resolution array detector, etc. for rapid detection and identification of target materials, and providing downwind hazard prediction data.
- miniature, hyphenated systems based on ion mobility spectrometry (IMS), mass spectrometry (MS) and gas chromatography (GC) (e.g., GC-IMS, IMS-MS, MS-MS, etc.), which rapidly detect and identify target materials.
- optimal detection and estimation of dynamic spectral signatures from current and advanced sensors, such as those described above.

These technologies have the potential to produce low-cost, high-performance, fully automated payloads compatible with unmanned air vehicles, unattended ground sensor and other mission requirements. Applications include chemical-biological detection on the battlefield, battle space surveillance, and covert collection.

PHASE I: Define the technique, its application, and the approach to miniaturization and/or detection and identification algorithm optimization. Determine limits to miniaturization, sensitivity, and specificity through simulation.

PHASE II: Design and construct a breadboard model of the proposed technique, and determine its performance through laboratory test and evaluation. Prepare and deliver documentation of the design and evaluation results.

COMMERCIAL POTENTIAL: Pollution monitoring, terrorist attack mitigation, medical, agricultural, geological, recycling and manufacturing applications of these technologies are envisioned.

REFERENCES:

1) Steven M. Kay ," Fundamentals of Statistical Signal Processing: Estimation Theory," Prentice Hall, Inc.,1993.
2) Charles W. Therrien, " Discrete Random Signals and Statistical Signal Processing," Prentice Hall, 1992.
3) P. Swain and S. Davis, Charles W. Therrien (eds.), "Remote Sensing: The Quantitative Approach," McGraw-Hill, 1983.
4) A. S. Mazer, M. Martin et al, "Image Processing Software for Imaging Spectrometry Data Analysis," Remote Sensing Environ., vol. 24, no. 1, p. 201, 1988.
5) S.C. Terry, J.H. Jerman and J.B. Angell, "A Gas Chromatographic Air Analyzer Fabricated on a Silicon Wafer," IEEE Transactions on Electron Devices, vol. ED-26, p. 1880, Dec 1979. 6) J.B. Angell, S.C. Terry and P.W. Barth, "Silicon Micromechanical Devices," Scientific American, vol 248, p. 44, 1983.
7) Hans W. Mocker and T.J. Wagener "Laser Doppler Optical Air-Data System: Feasibility Demonstration and Systems Specifications," Appl. Optics, vol 33, p.457, 1994.
8) L. H. Cohen, A. M. J. van Eijk, G. de Leeuw, "Pulsed Heterodyne CO2 Laser Rangefinder and Velocimeter with Chirp Correction," Appl. Optics, vol 33, 5665 (1994).
9) Y. Zhao, M. J. Post and R. M. Hardesty, "Receiving Efficiency of Monostatic Coherent Lidars. 1: Theory," Appl. Optics, vol 29, 4111 (1990); "2: Applications," Appl. Optics, vol 29, 4120 (1990).
10) J. F. Holmes and B.J. Rask, "Coherent, CW, Pseudo Random Code Modulated Lidar for Path Resolved Optical Remote Sensing," presented at the SPIE Conference on Atmospheric Propagation and Remote Sensing III, Orlando, Florida, April 1994.

ARPA SB961-037 TITLE: Video Retrieval Based on Language and Image Analysis

CATEGORY: 6.2 Exploratory Development; Command, Control and Communications

OBJECTIVE: Develop practical systems for automatic understanding and indexing of video sequences using both audio and video tracks.

DESCRIPTION: Automatic indexing of video is of increasing military and commercial interest. Military analysts must extract pertinent information from foreign television broadcasts, and must have the ability to rapidly locate segments from vast stores of video data. The design and construction of a system to extract content information from video sources, such as news broadcasts, video presentations, and video teleconferences, is desired. The information gleaned should be sufficient to support automatic indexing for later retrieval and/or automatic abstraction of video content.

Current approaches depend primarily on natural language understanding, which often fails to sufficiently categorize the associated imagery. What is needed is a system that can utilize both the audio and video to obtain retrieval terms that characterize the situation shown in the video. The audio and image analysis should work hand-in-hand to disambiguate terms, with imagery identifying speakers or objects, and language analysis providing keys to needed image analysis.

PHASE I: In detail, define an application, its data source, the desired output, an implementation framework, and the set of speech recognition and image understanding technologies that must be employed to achieve the result.

PHASE II: Develop a prototype video indexing system using the design from Phase I. The implementation should use COTS hardware and software as much as possible. Demonstrate the prototype on an existing archive of at least 12 hours of video.

COMMERCIAL POTENTIAL: The development of automatic video indexing systems will enable routine access to the vast quantity of video that is being captured digitally on a daily basis. Potential users of such systems include scholars doing academic research, journalists searching for background, TV producers editing video clips, legal assistants reviewing previous testimony, military analysts compiling databases on regions or topics of interest, etc. Further advancement of this technology could lead to applications beyond retrieval, such as advanced human-computer interfaces, in which the automated system reacts to the user based on both what it sees and hears.

REFERENCES:
1) Proceedings of the Workshop on Motion of Non-Rigid and Articulated Objects, Austin Texas, November 1994.
2) Proceedings of the Video Photogrammetry and Exploitation Conference, Washington DC, May 1995.
3) Journal of Multimedia Tools and Applications, Vol. 1 No. 1, March 1995.

ARPA SB961-038 TITLE: Lightweight, Low-Cost Surveillance Arrays

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Demonstrate advanced lightweight antennas that provide array adaptivity and limited electronic scanning while minimizing the number of phase shifters and receivers.

DESCRIPTION: Radars with large aperture antennas have small beamwidths and hence provide good angle accuracy. Conventional phased arrays can provide full electronic scanning and array adaptivity, but for large apertures they require a very large number of radiating elements and active control devices (i.e. phase shifters). This, in turn, leads to heavy and costly arrays. Other methods have been explored in the past that achieve a large aperture system by more efficient means. One such approach would be to use a lens or reflector fed by a multi-beam and/or steerable feed. ARPA is interested in exploring fully adaptive, lightweight surveillance radar array designs for airship and aerostat applications. The array should be fully electronically steerable in azimuth with limited scanning in elevation ($\pm 15°$ to $\pm 20°$). The receiver and transmitter may use the same antenna or separate antennas. The array must be adaptive in both azimuth and elevation, but care should be taken to minimize the total number of receivers.

PHASE I: Propose and evaluate alternate large aperture array concept(s). Model the array performance. Enumerate the array components. Describe the construction approach and estimate the array weight.

PHASE II: Build a prototype section of the lightweight array analyzed in Phase I and demonstrate the key performance parameters.

COMMERCIAL POTENTIAL: U.S. aerostat manufacturers serve an established market both domestically and internationally for both military and commercial applications. For example, systems have been sold to Korea, Iran, and Nigeria as communications nodes and for TV and radio broadcast. Aerostats also have been proposed as long endurance host platforms for remote environmental monitoring in areas such as rainforests. The advancement of lightweight array technology will serve to expand the commercial markets for these systems by providing more capable, lower-cost sensors to serve new markets, such as remote environmental sensing.

REFERENCES:

Antenna Handbook: Theory Applications and Design. Lo, Y.T. and S.W. Lee, editors. Van Nostrand Reinhold Company, New York, 1988, Chapter 19.

ARPA SB961-039 TITLE: Computational Intelligence Approaches to Automatic Target Recognition (ATR)

CATEGORY: 6.2 Exploratory Development; Computing and Software; Command, Control and Communications; Electronic Warfare

OBJECTIVE: Create and demonstrate computational intelligence techniques for model-based Automatic Target Recognition (ATR) systems.

DESCRIPTION: Model-based ATR systems offer great promise in reducing the number of false alarms, while increasing the quality of target classifications. Existing model-based ATR approaches maintain large databases in order to represent each individual target at a number of aspect and depression angles. As the scope of targets to be recognized on the battlefield increases, intelligent approaches to model retrieval and matching are required to achieve real-time system performance. For example, the use of neural networks or genetic algorithms in model matching offers potential in both reducing the training process and creating a parallelized "survival of the fittest" recognition scheme.

The goal of this task is to determine where computational intelligence techniques can be applied to improve model-based target recognition performance, particularly for Synthetic Aperture Radar (SAR) imagery. This task should quantify the possible improvements in contrast to existing approaches and generate a design plan for the implementation and evaluation of the proposed approach. Innovative and novel approaches that go beyond the model-based target recognition paradigm are also of interest.

PHASE I: In detail, define and construct limited prototypes for the technique or algorithm proposed for use in model-based ATR systems. Provide detailed estimates of the technique's impact on ATR computational and functional performance. Research and document the system's applicability to medical and manufacturing vision systems.

PHASE II: Implement the proposed technique or algorithm. Demonstrate, evaluate, and document computational and functional performance gains achieved with the technique or algorithm.

COMMERCIAL POTENTIAL: These methods could have significant commercial impact in lowering costs and improving performance in medical and manufacturing vision systems.

ARPA SB961-040 TITLE: Alternate Power Sources for Aerostats

CATEGORY: 6.2 Exploratory Development; Aerospace Propulsion and Power

OBJECTIVE: Demonstrate advanced aerostat power source technology to provide higher levels of prime power and improved weight efficiency relative to current systems.

DESCRIPTION: Current aerostat systems require from 10 to 30 kVA of prime power to operate the sensor payloads, as well as perform housekeeping functions. Two approaches are currently used. The first is to use an onboard engine/generator (gas or diesel). The second is to employ a "power-up tether." Each method has its advantages and disadvantages. For example, onboard engines require substantial onboard fuel supplies and thus must be brought down periodically for refueling. Power-up tethers, on the other hand, are heavy and require more delicate handling than non-powered tethers. This SBIR request is to study alternate power source techniques and advanced lightweight power-up tethers, and evaluate their effectiveness. This may include, for example, wind generated power, advanced fuel cells, ground-to-aerostat microwave power transmission, etc. The system power levels that are desired range from 30 to 100 kVA and the flight altitudes of interest range from 10 to 25 kft (nominally 20 kft).

PHASE I: Propose and evaluate alternate power generation concept(s). Compare the performance to existing systems. Quantify the improvement. Evaluate feasibility. Consider issues such as payload weight, endurance, drag impacts, and ease of deployment.

PHASE II: Build a prototype of the alternate power generation system analyzed in Phase I and demonstrate the key performance parameters.

COMMERCIAL POTENTIAL: U.S. aerostat manufacturers serve an established market both domestically and internationally for both military and commercial applications. For example, systems have been sold to Korea, Iran, and Nigeria as communications nodes and for TV and radio broadcast. Aerostats also have been proposed as long endurance host platforms for remote environmental monitoring in areas such as rainforests. The advancement of power source technology will serve to expand the commercial markets for these systems by providing more efficient, lighter weight power systems and longer endurance platform performance.

REFERENCES:

11th AIAA Lighter-Than-Air Systems Technology Conference Proceedings, May 15-18, 1995

ARPA SB961-041 TITLE: Rapid Target Model Development and Validation

CATEGORY: 6.2 Exploratory Development; Modeling and Simulation; Computing and Software; Command, Control and Communications; Electronic Warfare

OBJECTIVE: Create and demonstrate target model building and target model validation tools that will enable rapid, low-cost creation of target models for Automatic Target Cuing and Recognition (ATC/R) systems.

DESCRIPTION: The construction and validation of models of target vehicles for use in ATC/R systems is time consuming and costly. A typical model build and validate process may take on the order of tens of man months for a complex, multi-step, model building and validation process. The steps are as follows: 1) initial physical CAD model preparation, 2) CAD model validation (comparison of the model to target exemplars to ensure geometric fidelity), 3) augmentation of the physical CAD representation with sensor-specific extensions (dielectric properties for radar or thermal properties for infrared imagery), and 4) sensor-specific validation (extensive comparisons of collected imagery with high-fidelity simulated imagery, derived from the augmented models).

New, innovative and cost-effective methods for building and validating such models are sought, particularly for Synthetic Aperture Radar (SAR) imagery. Such methods will decrease the overall costs of such model building, and radically decrease the amount of time and data needed to create and validate such models. Such methods may include, but are not limited to, techniques from the following list: 1) the creation and validation of SAR-significant models of potential targets using limited amounts and limited views of the target in surveillance imagery, 2) the rapid creation of CAD models of new targets using advanced scanning or survey techniques, 3) the creation of tools and methods for automating the SAR-specific target model validation process, and 4) methods for adapting and/or modifying existing, validated SAR models to represent new, previously unseen targets.

PHASE I: In detail, define and construct limited prototypes for the proposed target model building and validation approach, addressing methods to be employed, data needed for model creation/validation, time needed for creation/validation, and process improvement gains over existing techniques.

PHASE II: Implement the proposed target model building and validation system and demonstrate the improved processes by building target models and documenting process improvement gains.

COMMERCIAL POTENTIAL: These methods will also have significant commercial impact in lowering costs for the creation of high fidelity CAD models for manufacturing and graphical simulation.

ARPA SB961-042 TITLE: Development of Holographic Memory for Use In Optical Correlators

CATEGORY: 6.1 Basic Research; Materials, Processes and Structures

OBJECTIVE: Develop a holographic memory that can store several thousand 512x512 images such that all images can be accessed within one second. Parallel access to the images is preferred.

DESCRIPTION: A holographic memory in an optical correlator may be used to store space- or frequency-domain images to be compared or correlated with an input scene in order to detect and classify potential targets within that scene. The holographic memory developed should be capable of satisfying the following parameters: temperature and humidity insensitive when addressing, "write once, read many," a cycle time of one second or less to address all stored holograms, preferably addressable with a minimal power laser source within the wavelength range of 0.6-1.0 microns, and contains few or no moving parts.

Furthermore, the design of this holographic memory may be based on wavelength or angular multiplexing schemes. Consideration should be given to achieving minimal bit error rates when addressing the stored images.

PHASE I: Design a holographic memory utilizing existing materials. Provide experimental data showing that the materials chosen are viable to meet the above parameters.

PHASE II: Construct a holographic memory and demonstrate the storage capacity desired with minimal bit error rate upon addressing.

COMMERCIAL POTENTIAL: Volume holographic memory is advantageous whenever there is a need for fast parallel processing of pages of information. It is ideally suited for automatic target recognition for military applications because a holographic memory can parallel process hundreds of scenes, thereby keeping up with the flow of images coming in from sensors. Similarly in industry, holographic memory can be used for identification purposes where processing time is important. Holographic memories are ideally suited for assembly line work where there is a constant flow of input. Robotic vision systems to orient parts on an assembly line are one example. With a robotic vision system, the current orientation of the part can be instantly determined in the same manner that the military's automatic target recognition system identifies targets. The corresponding instruction set can be sent to the robot to re-orient the part precisely to the desired position. Repeated turning and rechecking the part's orientation would not be necessary. A second use is in optical computing. Holographic memories are best for looking at pages of information rather than the traditional computing method of processing bits at a time. Holographic memories are also being looked at for storing large instruction sets and neural networks for optical computers.

REFERENCES:
F.H. Mok, M.C. Tackitt, and H.M. Stoll, "Storage of 500 High-Resolution Holograms in a LiNbO3 Crystal," Optics Letters 16 (8), 605-607 (1991).

ARPA SB961-043 TITLE: Non-Linear Optic Materials for Protection of Optical and Electro-Optical Sensors

CATEGORY: 6.1 Basic Research; Sensors, Electronic Warfare

OBJECTIVE: Develop non-linear, optical materials with low switching thresholds, fast (sub-picosecond) switching times and wide dynamic range for protection of optical and electro-optical sensors from high intensity light sources at visible wave lengths.

DESCRIPTION: An intensive effort has been conducted during the past several years to develop materials which display strongly non-linear, optical absorption properties. Organometallic macrocyclic dyes and carbon particles suspensions, for example, are materials which display favorable non-linear properties for application to protection of sensors from laser beams and other intense light sources. However, switching thresholds for these materials are higher than desired, and dynamic ranges are less than desired. There is a requirement for materials with larger, non-linear absorption coefficients and higher damage thresholds. Concepts for producing materials with enhanced non-linear properties by molecular engineering, synthesis of small particle composites, or other approaches are solicited.

PHASE I: Construct/fabricate/synthesize the non-linear material and perform absorption measurements to demonstrate proof of principal.

PHASE II: Improve material properties and thoroughly characterize the intrinsic nonlinear properties of the material. Incorporate the material into a mock-up of a military sensor system and demonstrate effectiveness in protecting the sensor from intense light sources.

COMMERCIAL POTENTIAL: These materials, when successfully demonstrated, have application to safety glasses and other eye protection applications in commercial industry. Lasers are becoming more common place in the manufacturing industry and, as this occurs, eye safety becomes more of a problem, as does the protection of various sensor systems utilized in the manufacturing process.

REFERENCES:
1) M. Sheik-bahae, A.A. Said, and E.W. Van Stryland, "High Sensitivity, Single Beam n_2 Measurements," Opt. Letter, Vol. 14, p.955-957 (1989).
2) M.J. Soilean, T.H. Wel, M. Sheik-bahae, D.J. Hagan, Martine Sence, and E.W. Van Stryland, "Non-linear Optical Charaterization of Organic Materials," Conference Proceedings.
3) Kenneth LaiHing, "Third Order Susceptibility of Silver Sulfide Sol," Technical Report, Contract # DAAH01-92-P-R021, December 1992.

4) Kenneth LaiHing, "Third Order Susceptibility of Silver Sulfide Colloid," Technical Report, Contract # DAAH01-92-P-R021, December 1992.
5) Kenneth LaiHing, "Third Order Susceptibility of Platnium Sulfide Sol," Technical Report, Contract # DAAH01-92-P-R021, December 1992.
6) Kenneth LaiHing, "Third Order Susceptibility of Gold Sulfide Sol," Techncial Report, Contract # DAAH01-92-P-R021, December 1992.
Requests for the last four technical reports should be referred to (703) 696-2448.

ARPA SB961-044 TITLE: Millimeter Wave/Infrared Dichroic Beam Combiner

CATEGORY: 6.2 Exploratory Development; Materials, Processes and Structures

OBJECTIVE: Develop samples of dichroic beam combiner materials which transmit millimeter wave electromagnetic waves and reflect infrared light.

DESCRIPTION: Missile systems simulation activities require a dichroic beam combiner element for inclusion in an existing millimeter wave (MMW), hardware-in-the-loop (HWIL) simulator which will transmit MMW electromagnetic plane waves while simultaneously reflecting collimated Infrared (IR) light. This modification to the MMW simulator will allow HWIL simulations to be executed in support of dual-mode common-aperture MMW/IR guided missile system development. The approach taken will result in the ultimate development of dichroic elements which are efficient at transmitting MMW and reflecting IR, and which can be manufactured with physical sizes of at least three feet by three feet.

PHASE I: Produce samples of dichroic beam combiner materials for MMW and IR characterization. Demonstrate that the sample sizes can be grown to meet the ultimate size requirements indicated.

PHASE II: Develop larger samples of the materials which can be readily integrated into an existing MMW simulator for use in HWIL simulations of dual-mode common-aperture MMW/IR guided missile systems.

COMMERCIAL POTENTIAL: Dichroic beam combiners are required for the next generation of Earth Resources satellites that are being developed by NOAA and private industry. A dichroic beam combiner makes it possible to simultaneously collect energy from two separate parts of the spectrum through a common aperture. A common aperture offers the advantage of size and weight efficiency, and minimizes image registration problems. Remote sensing and processing of multispectral signatures will provide significant improvement in important areas, such as: evaluation of crop states; estimation of the water content of the soil and atmosphere; presence of pollution agents in the atmosphere, streams, and rivers; imminence of volcanic eruptions; extent of forest fires; and any other phenomena that can be properly observed only by high altitude, remote sensing platforms. This SBIR task has a very high potential for developing efficient, expensive, and lightweight dichroic beam combiner technology that can be applied to remote sensing applications.

REFERENCES:
S.B. Mobley, "U.S. Army Missile Command Dual-Mode Millimeter Wave/Infrared Simulator Development," Characterization, Propogation, and Simulation of Sources and Backgrounds IV, SPIE Proceedings, Vol. 1967, April 1994.

DEFENSE NUCLEAR AGENCY

The Defense Nuclear Agency is seeking small businesses with a strong research and development capability and experience in nuclear weapon effects, phenomenology, operations and counterproliferation. (Note we are not interested in nuclear weapon design or manufacture.) DNA invites small businesses to send proposals to the following address:

Defense Nuclear Agency
ATTN: AM/SBIR
6801 Telegraph Road
Alexandria, VA 22310-3398

The proposals will be processed and distributed to the appropriate technical offices for evaluation. Questions concerning the administration of the SBIR program and proposal preparation should be directed to:

Defense Nuclear Agency
ATTN: AM/SADBU, Mr. Bill Burks
6801 Telegraph Road
Alexandria, VA 22310-3398
Tel: (703) 325-5021

DNA has identified 22 technical topics numbered DNA96-001 through DNA96-022. These are the only topics for which proposals will be accepted. The current topics and topic descriptions are included below. These topics were initiated by the DNA technical offices which manage the research and development in these areas. Several of the topics are intentionally broad to ensure any innovative idea which fits within DNA's mission may be submitted. Proposals do not need to cover all aspects of these broad topics. Questions concerning the topics should be submitted to:

Defense Nuclear Agency
ATTN: TAIC, Mr. David R. Lewis
6801 Telegraph Road
Alexandria, VA 22310-3398
Tel: (703) 325-1215

DNA selects proposals for funding based on the technical merit, criticality of the research, and the evaluation criteria contained in this solicitation document. As funding is limited, DNA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and filling the most critical requirements. As a result, DNA may fund more than one proposal under a specific topic or it may fund no proposals in a topic area. Proposals which cover more than one DNA topic should only be submitted once.

DNA has not set aside funds for bridge funding. As such, proposers should not rely on bridge funding to cover the time gap between Phase I and Phase II.

DEFENSE NUCLEAR AGENCY
FY 1996 SBIR TOPIC INDEX

Subject Index for the DNA SBIR Solicitation

DEFENSE NUCLEAR AGENCY TOPICS

DNA 96-001 TITLE: Nuclear Weapon Effects Phenomenology

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop innovative algorithms to improve our understanding of nuclear weapon effects and the implementation of these algorithms.

DESCRIPTION: To improve the understanding of the impact of nuclear weapons under battlefield conditions, we require more accurate, efficient, user-friendly methods of calculating and displaying the affects of nuclear scenarios and their operational impact. Areas of interest include: improved accuracy even as calculational times are minimized; reliance on basic physical principles validated by measured test results; faster running calculations; and new and improved ways to enable users (be they advanced nuclear weapons effects researchers, weapon systems developers, or managers with limited nuclear weapons effects experience) to calculate, estimate, and appreciate nuclear weapon effects and their system impacts. Nuclear weapon effects include airblast; ground shock; water shock; cratering; thermal radiation; neutron, gamma and x-ray radiation; electromagnetic pulse; fallout; blueout; blackout; redout; and dust cloud formation.

Improved methods are required for the management of technical information that relates to the archival of nuclear weapon phenomenology and test data, as well as input to and retrieval of such data archives. Methods for developing unifying test data standards devised with application beyond just nuclear test effects are needed to improve data processing efficiency and reduce hardware and software specific requirements.

During Phase I, the research will demonstrate the feasibility of the proposed approach to improve the understanding of nuclear weapon effects or the archival and ease of use of stored data.

During Phase II, the research concepts developed in Phase I will be further developed and incorporated into appropriate codes.

COMMERCIAL POTENTIAL: Computer codes related to earthquake effects, pollution transport, signal propagation, data archival, and test standards for data.

REFERENCES:
(1) DNA EM-1, Capabilities of Nuclear Weapons
(2) Glasstone, The Effects of Nuclear Weapons

DNA 96-002 TITLE: Response of Materials and Structures to Nuclear and Conventional Weapon Effects

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Improve the survivability of weapon systems by using innovative materials and structure designs

DESCRIPTION: Of interest to DNA is understanding the response of materials, structures, and systems to nuclear weapons effects. Materials of interest include metals, ceramics and composites. New materials capable of being used as a structural members for aircraft, missiles, ships, submarines and military vehicles are of particular concern. New materials with enhanced electromagnetic shielding properties are also of interest.

Improved understanding of the failure mechanisms of structures is required. Potential utilization of underground test (UGT) tunnel response data to earthquake design criteria for underground structures. Type of structures include deep underground, land-based (fixed and mobile), sea-based (floating and submerged) and aerospace structures. Conventional as well as nuclear weapons effects are of interest. Improved methods are needed for analysis and model testing of structures to large deflection and collapse damage levels. Structures of interest include deep underground, land-based, sea-based, and aerospace structures.

During Phase I, the research will demonstrate the feasibility of the proposed designs/methodology to determine material or structural response to nuclear weapon effects.

During Phase II, the research concept developed in Phase I will be further developed where, if appropriate, the concepts will be incorporated into other existing methodology, codes, or structural designs.

COMMERCIAL POTENTIAL: Earthquake resistant buildings, underground facilities such as transportation and utility tunnels,

and material and design improvements for structures, ships, aircraft, and vehicles.

REFERENCES: (1) DNA EM-1, Capabilities of Nuclear Weapons
(2) Glasstone, The Effects of Nuclear Weapons.

DNA 96-003 TITLE: Nuclear Weapon Effects on Electronics

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Explore the effects produced by nuclear radiation and electromagnetic pulse on electronics.

DESCRIPTION: The nature and magnitude of the effects produced by the interaction of nuclear-weapon produced radiation on electronics, electronic systems, opto-electrical devices, and sensors in the phenomenology areas of: a) Transient Radiation Effects on Electronics (TREE); b) Electromagnetic Pulse (EMP); c) System Generated EMP (SGEMP); and d) Source Region EMP (SREMP) are of interest to DNA. Particular areas of concern include: methods by which designers of space, strategic and tactical systems can assess their susceptibility to these effects; technologies to reduce the susceptibilities of electronic systems and devices (especially those with submicron feature sizes) to acceptable levels; and methods to demonstrate survivability under specified threat criteria. Concepts and techniques to model the nuclear radiation and electromagnetic system effects in the distributed interactive simulation (DIS) format are required. Concepts and techniques to improve the survivability (decrease the response) of systems against these nuclear weapons effects are required.

During Phase I, initial feasibility studies will be completed to demonstrate the viability of the proposed approach.

During Phase II, continue the investigation which was begun in Phase I to fully develop and demonstrate the proposed approach.

COMMERCIAL POTENTIAL: Commercial satellites and electromagnetic interference/compatibility.

REFERENCES: (1) DNA EM-1, Capabilities of Nuclear Weapons
(2) Glasstone, The Effects of Nuclear Weapons.

DNA 96-004 TITLE: Nuclear Weapon Effects on Communication, Sensor Operability, and Signal Propagation

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Investigate the effects of nuclear weapon explosion on electromagnetic and optical/signals, and the subsequent impact on the performance of communication and sensor systems.

DESCRIPTION: The Defense Nuclear Agency is interested in the basic physical processes which describe the interaction of nuclear weapons with the atmosphere, which create environments that degrade the propagation of communication and radar signals and that contain optical clutter backgrounds which degrade optical sensor systems. Part of DNA's mission is to predict effects on and determine mitigation methods for, DoD systems such as satellite communications, VLF/LF communications, HF/VHF/UHF communications, radar systems, and optical sensor systems. Areas of interest include mechanisms for the coupling of nuclear weapon energy to the atmosphere; the development of structure in weapon produced plasmas and molecular emitters; the chemical processes which give rise to the optical emissions; the transport and final deposition of nuclear debris; the effects of degraded signal propagation on the performance of communication systems and radars; and the prediction of the effects of optical clutter backgrounds on the performance of optical sensor systems. Areas of interest also include the development of improved communications and sensor methods to mitigate atmospheric effects on systems and the development and application of simulators to test DoD systems in stressed environments.

During Phase I, demonstrate the feasibility of the proposed investigation to advance the understanding in any of the areas described above.

During Phase II, continue the investigation to develop a product or result that can be incorporated into the existing technology base.

COMMERCIAL POTENTIAL: Commercial communication systems and space sensors, and predictions of operational effects produced by solar events.

REFERENCES: (1) DNA EM-1, Capabilities of Nuclear Weapons
(2) Glasstone, The Effects of Nuclear Weapons.

DNA 96-005 TITLE: Nuclear Hardening and Survivability

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop innovative technologies to improve the nuclear hardening and survivability of DOD systems.

DESCRIPTION: Improved techniques for nuclear hardening and survivability of weapon systems, against nuclear weapons effects are required. These techniques should protect the system against the effects of blast, thermal, nuclear radiation, and electromagnetic pulse. In particular, the ability to harden communications facilities and surveillance sensors against electromagnetic pulse is of interest. Systems include planned and operational, strategic and tactical, ground mobile, missile, aircraft, and space systems and their subsystems and components.

During Phase I, demonstrate the feasibility and usefulness of the proposed technique.

During Phase II, fully develop the proposed technique and characterize its usefulness in both technical and cost terms.

COMMERCIAL POTENTIAL: Improved buildings, electronics, aircraft, satellites and better electromagnetic shielding.

REFERENCES: (1) Mil-Std-188-125
(2) Mil-Hdbk-423
(3) DNA EM-1, Capabilities of Nuclear Weapons
(4) Glasstone, The Effects of Nuclear Weapons

DNA 96-006 TITLE: Radiation Hardening of Microelectronics

CATEGORY: Exploratory Development, Electronic Devices

OBJECTIVE: Develop and demonstrate technology to: (1) radiation harden; (2) improve reliability and electrical performance; (3) improve radiation hardness and reliability assurance methods; and (4) characterize the radiation and reliability response of semiconductor devices (microelectronics and optoelectronics) including warm and cold operation metal oxide semiconductor (MOS), bipolar, and compound material technologies.

DESCRIPTION: The trend in semiconductor integrated circuits and sensors is toward increasingly higher levels of integration density, higher speeds, higher on-chip circuit complexity, lower voltage and power, and larger die size. All of these trends have exacerbated the problems associated with radiation hardening reliability, and testability. In addition, improvements in material science have lead to the introduction of a wide variety of compound semiconductor materials into microelectronic and optoelectronic applications. The radiation and reliability responses of these materials is lacking or unknown.

Thus, it is the objective of this topic to develop and demonstrate innovative technology and methods to: (1) ensure that these devices can operate in a radiation or other stressing environment (e.g. very high or low temperatures); (2) improve device reliability; (3) improve producibility and yield; (4) develop cost-effective hardness and reliability assurance methods; (5) investigate and characterize the radiation response and reliability performance of these devices and associated materials; and (6) maintain device performance without degrading robustness. The development of technologies which enhance reliability, producibility, and yield will support the commercial semiconductor sector. In addition, the development of methods to improve the survivability of microelectronics in severe stressing environments is directly related to the commercial semiconductor and electronics industries.

During Phase I, the research will demonstrate the feasibility of the proposed technology and methods concepts.

During Phase II, the research concepts developed in Phase I will be demonstrated or reduced to engineering practice.

COMMERCIAL POTENTIAL: Robust microelectronics, satellites, high temperature sensors.

DNA 96-007 TITLE: Nuclear Weapon Effects Simulation Technology

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Improve the state-of-the-art in nuclear weapon effects simulation technologies.

DESCRIPTION: Simulators are needed to: provide experimental data for development of numerical simulations of nuclear weapons effects; simulate one or more nuclear weapons effects at laboratory size scale; and improve weapon system test capability. Simulation requirements include airblast over various surface conditions, dusty flow, dust lofting, shock propagation in rock, water shock, thermal radiation, EMP, and nuclear radiation.

Existing large scale simulators are often expensive and time consuming to operate, and require travel to an explosive test site. Small scale simulators are needed to provide extensive data to supplement the limited amount of data available from the large scale simulators. Innovative simulators are needed which are economical and simple to operate. Innovative ideas are needed on how to use very small scale simulators to produce useful information.

During Phase I, demonstrate the basic simulator concept.

During Phase II, demonstrate a laboratory scale simulator and produce useful data.

COMMERCIAL POTENTIAL: Numerical analysis; metrology; earthquake, hurricane, and tornado survivability.

REFERENCES: DASIAC-SR-92-0006, Guide to Nuclear Weapons Effects Simulation Facilities and Techniques - 1992 Edition

DNA 96-008 TITLE: Instrumentation

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Advance the state-of-the-art in nuclear and conventional weapon effects instrumentation.

DESCRIPTION: Instrumentation is used for measuring nuclear and conventional weapon effects including: phenomenology parameters and the response of test items exposed to conventional or simulated nuclear weapon effects. The instrumentation should be capable of operating under very harsh conditions, such as might be encountered in blast and shock tests, or tests involving high levels of x-ray, gamma, or neutron radiation. Instrumentation is needed for the following types of tests: airblast, ground shock, dusty flow, dust lofting, water shock, shock propagation in rock, High Explosive (HE), nuclear radiation (x-rays and gamma rays), thermal radiation, electromagnetic pulse (EMP) (high altitude or systems generated), and for improved data acquisition (transmission and recording). Desirable improvements include costs, ease of use, precision, accuracy, reliability, ease of calibration (preferably on site) and maintainability. Some current problems are the ability to make airblast and thermal measurements in an explosive debris environment, making explosive characterization measurements inside the high explosive itself during detonation, and do full characterization of debris (size and momentum) from encased explosive detonations.

During Phase I, build a prototype instrument or instrument system and demonstrate its performance in laboratory scale testing.

During Phase II, design, build, and test a full scale instrument system demonstrating its performance in its intended working environment. This may involve coordination with DNA to schedule testing in a simulator.

COMMERCIAL POTENTIAL: Metrology, Blasting Operations, Earthquake studies, radiation testing/monitoring, large structure (e.g., buildings, dams, and mines) integrity, fire protection, lightning protection, hazardous waste containment.

REFERENCES:
(1) DNA INWET Conference Announcement Brochure ,1993 and 1991
(2) Glasstone and Dolan, The Effects of Nuclear Weapons, 1977
(3) DNA EM-1, Capabilities of Nuclear Weapons (Classified)
(4) DASIAC-SR-92-0006, Guide to Nuclear Weapons Effects Simulation Facilities and techniques - 1992 Edition

DNA 96-009 TITLE: X-Ray Effect Simulation Technology

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop innovative technologies for the production of x-ray radiation.

DESCRIPTION: Future requirements for x-ray nuclear weapon effects testing will require vast improvements in existing radiation source capability as well as new concepts for producing soft x-rays (1-5 keV), warm x-rays (5-15 keV), and hot x-rays (>15 keV). Soft x-rays are used for optical and optical coatings effects testing. Warm x-rays are used for thermomechanical and thermostructural response testing; and hot x-rays are used for electronics effects testing. The proposer should be familiar with the present capability to produce x-rays for weapon effects testing.

Present Plasma Radiation Source (PRS) x-ray sources generate copious amounts of debris (material, atomic charged particles, sub-keV photons). Debris production is an even greater concern for the simulators currently under development. New measurement and analysis technologies are required to characterize the source and the debris generated from wire array and z-pinch PRS sources to better understand debris sources and mitigation. Existing debris shield technologies are not adequate to support larger exposure areas and cleaner test environments while minimizing fluence degradation. New methods, or combination of methods, need to be developed to stop, mitigate, and/or delay debris generated for radiation simulators.

New technologies to measure plasma parameters for simulator sub-systems such as plasma opening switches and plasma sources are of interest. Test response diagnostic technologies are required to measure the full time and spectral history of the radiation pulse across the breadth and width of the test asset as well as the response of the test asset during and after irradiation. Pulsed power diagnostic technologies are required for accurate, in-situ measurement of voltages and currents within the various simulator subsystems in order to monitor and characterize simulator performance. Diagnostic systems include required sensors/detectors, cabling, recording equipment and media, and, if necessary, computer systems and software.

During Phase I, demonstrate the feasibility of the proposed concept.

During Phase II, develop, test, and evaluate proof-of-principle hardware in its working environment on a radiation simulator. This will involve coordination with DNA to schedule testing in a aboveground test simulator.

COMMERCIAL POTENTIAL: Nuclear instrumentation, very fast closing valves and bright X-ray sources.

REFERENCES: DASIAC-SR-92-0006, Guide to Nuclear Weapons Effects Simulation Facilities and Techniques - 1992 Edition

DNA 96-010 TITLE: Distributed Interactive Simulation of Nuclear Weapons Effects

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Incorporate nuclear weapons effects and adapted nuclear effects technology into the Distributed Interactive Simulation (DIS) protocol

DESCRIPTION: Nuclear Survivability testing of new acquisitions and design modifications can be accomplished prior to "bending metal" through the use of the Distributed Interactive Simulation protocols and battlefield synthetic environment "testing". However, such assessments require validated systems models, nuclear environments and response algorithms; all capable of operating within the approved set of DIS protocol data units (PDUs).

Improved methods for nuclear environmental and effects representation within the DIS protocol are needed to calculate and assess such nuclear effects on systems (equipment and personnel) as prompt radiation (gamma, x-ray and neutron), protracted radiation, airblast, ground shock, water shock, cratering, thermal radiation, electromagnetic pulse, blackout and redout.

There have also been adaptations of nuclear effects technology to non-nuclear applications. Included are disaster planning tools for such natural disasters as hurricanes and earthquakes. Improved methods for representation of natural disaster damage and its impacts within the DIS protocol are needed to facilitate visual representation of the disaster and to train emergency managers/responders for appropriate responses.

During Phase I, the research will demonstrate the feasibility of the proposed approach to represent nuclear environments and effects in the DIS protocol.

During Phase II, the research concepts developed in Phase I will be further developed, tested, validated and submitted for inclusion into the IEEE PDU standards.

COMMERCIAL POTENTIAL: Emergency Management Training

DNA 96-011 TITLE: Nuclear Forces Security and Survivability Technologies

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Improved security and survivability of US nuclear forces.

DESCRIPTION: The possible possession of weapons of mass destruction (WMD) is of vital concern to prelaunch survivability (PLS) of nuclear forces. New and innovative concepts to improve PLS are needed to retain a viable nuclear strike capability and to enhance deterrence. The threats include enemy forces conducting unconventional, conventional, chemical and nuclear warfare during periods of peacetime, transition to war, and war. Long range program thrusts include peacetime and field storage, deceptive/OPSEC practices, nuclear force movements, and operational survivability of nuclear systems (aircraft and missiles). Concepts should employ innovative ideas and make use of new and emerging technologies. Work will include detector technology improvements and advanced algorithms for improved signal to noise ratio.

Measures to improve the security of nuclear weapons against all possible threats are required. Security measures include detection, assessment, delay and denial systems. Proposals should describe how they will improve protection against known and predicted threats and should emphasize weapon concealment where appropriate.

During Phase I, demonstrate the feasibility and potential usefulness of the proposed security or survivability technologies.

During Phase II, fully develop the proposed technologies so they can be compared to existing techniques.

COMMERCIAL POTENTIAL: Commercial Security Systems

DNA 96-012 TITLE: Operational Planning and Targeting Technology

CATEGORY: Exploratory Development, Communications Networking

OBJECTIVE: Improved ability of US nuclear commanders to plan for nuclear engagements and target nuclear weapons.

DESCRIPTION: The nuclear employment planning capabilities of operational commanders in tactical, strategic and integrated warfare environments require improvement. These improvements include development of automated planning systems; technologies to determine target damage objective and criteria; post strike target damage assessment capabilities; and automated nuclear weapon employment codes. Techniques to account for electromagnetic effects in operational planning and exercises are also desired.

During Phase I, develop the proposed technology in sufficient detail to demonstrate its feasibility.

During Phase II, continue the development of the proposed technology to the point it can be incorporated into existing planning/targeting methodologies.

COMMERCIAL POTENTIAL: Logistics planning, shipping route planning.

DNA 96-013 TITLE: Verification Technology Development

CATEGORY: Advanced Development, Sensors

OBJECTIVE: Improve/develop US technical capability to verify/monitor compliance with existing and potential future arms control treaties, agreements, and confidence and security building measures, e.g., START, INF, CW, CFE, NTT, SNF, CTBT, CCWC, Open Skys and Presidential Initiatives.

DESCRIPTION: New arms control measures are being negotiated. New verification technologies and methods will be required to accurately monitor compliance to the provisions of any treaties or agreements that could result from the on-going negotiations or provide confidence building information. One problem will involve being able to distinguish between permitted activities and prohibited activities where the technical signatures between the two could be very minor. Another might include providing information to reduce tensions or intervene in crises.

During Phase I, demonstrate the feasibility of the proposed technology in relation to a potential arms control or confidence building application.

During Phase II, develop a proof of design to demonstrate the proposed technology.

COMMERCIAL POTENTIAL: Inventory Systems, Chemical Monitoring Systems

REFERENCES: Program Plan for Research, Development, Test and Evaluation for Arms Control Cooperative Inspection FY 93-95, OUSD(A), 4 Jan 93

DNA 96-014 TITLE: Counterproliferation Technology

CATEGORY: Exploratory Development, Sensors

OBJECTIVE: Develop new technologies for countering the proliferation of weapons of mass destruction.

DESCRIPTION: In support of the Department of Defense counterproliferation initiative, the Defense Nuclear Agency (DNA) is interested in identifying and integrating proven and maturing technologies to develop and demonstrate an operational capability to counter the proliferation of nuclear, biological, and/or chemical (NBC) weapons of mass destruction (WMD) located in a spectrum of facilities.

In Phase I, DNA is interested in initiatives in the following technical areas:

Hardened Target Defeat. Develop physical/functional lethality criteria for conventional weapons, including precision guided munitions, and advanced non-nuclear weapon payloads. Of particular interest are the development of shaft and portal vulnerability models. The models will be validated via weapon testing against simulated NBC targets.

Proliferation Path Analysis. Develop analytical models to predict the activities needed for development of NBC weapons programs by rogue nations. The model will alert DoD to potential proliferation activities and identify vulnerable chokepoints in the proliferation process for option development possible exploitation.

Enhanced Conventional Weapons Payloads Concepts. Develop concepts for the use of non-nuclear payloads delivered by penetrating weapons and released inside hardened NBC research/production/storage facilities to provide a significant increase in effectiveness (i.e. functional kill) over current conventional high explosive warheads. Of particular interest are payload concepts limiting the production of blast and high pressure gases, reducing collateral damage or nuclear/biological/chemical agent dispersal.

Collateral Effects Prediction Technology. Develop technology to define and predict weapon and target environments that cause unintended casualties. Of particular interest are improved atmospheric transport and dispersal models to provide significantly improved meteorological predictions along with embedded source term and transport models. The effort will also provide validated models to rapidly assess the effects of a strike on a NBC facility. End product will be a deployable collateral effects assessment capability for planners, decision makers, and users.

Targeting Technical Assistance. Develop technology to assist the theater user in conducting pre-attack weaponeering (including collateral effects prediction/mitigation) and post-attack battle damage assessment. Areas of emphasis include development of tools for proliferation path analysis, target planning, and collateral effects prediction/mitigation. End product will be a deployable expert system for operational planners using analytic prediction tools, multimedia hypertext databases, and technical manuals in concert with applied research, with possible sensor data use for condition updates.

Target Signature Evaluation. Develop sensor technology and analytical procedures for NBC target pre-attack characterization by understanding the operational aspects of target facility missions, architecture, prime mission equipment, critical subsystems, and functional vulnerabilities. The sensors must also provide data on weapon performance and reliable battle damage assessment. Of particular interest are air-dropped or man-emplaced unattended ground sensors, including hyper-spectral, seismic, thermal, electromagnetic, acoustic, gravimetric, and chemical.

Agent Neutralization. Provide a basic understanding of chemical and biological weapons response to weapons environments. Specifically, provide data and models describing the neutralization of threat agents to thermal, shock, and ionizing radiation environments. In addition, define the collateral effects source terms (quantity of agent released in viable form) of downed hostile

cruise missiles carrying biological agent payloads.

Counterproliferation Advanced Concept Technology Demonstration (ACTD). Develop basic research to complete the development of codes and analytical models for weather, collateral effects, target/weapon interaction described above.

In Phase II, develop promising technologies to be used.

In Phase III, will be inclusion to the end-to-end ACTD to be conducted. The ACTD will feature pre-attack site characterization using sensors and analytic tools. High-fidelity targets (simulating hardened WMD targets) will be attacked using a variety of advanced conventional payloads to evaluate penetration, lethality, and collateral effects. Sensors will also be used to determine weapon performance and battle damage assessment.

COMMERCIAL POTENTIAL: Characterization and warning sensor technology. Software decision and tracking models. Environmental modeling. Structural Dynamics predictive tools.

REFERENCES:
(1) Presidential Decision Directive/NSC-13 (Classified Subject).
(2) SECDEF Remarks to the National Academy of Sciences Committee on International Security and Arms Control, 7 Dec 1993 ("The Five Dangers").
(3) Deutch, Report on Nonproliferation and Counterproliferation Activities and Programs, May 1994.
(4) 1992 Defense Science Board Summer Study on Technical Military Capabilities for Future Contingencies: Countering Weapons of Mass Destruction in Contingency Operations, March 1993

DNA 96-015 TITLE: Pulsed Power Technology and Applications

CATEGORY: Exploratory Development, Energy Storage

OBJECTIVE: Dramatic improvements in energy storage, switching, and power conditioning technologies.

DESCRIPTION: Future requirements for systems employing pulsed power will necessitate improvements in efficiency, energy density, reliability, repeatability and overall performance over the existing state-of-the-art. Innovative approaches for component or subsystem development are sought to meet future demands for radiation simulators and other pulsed power applications. Examples include more efficient pulse forming technologies, high energy density capacitors, more efficient insulators, improved and more reliable switching technologies, and improved power flow electrical circuit models. Pulsed power applications include operation at kilovolts to megavolts, kiloamperes to megaamperes, and repetition rates from single pulse to 10 kilohertz. New diagnostics used to enhance the operation of the various pulsed power elements are required.

Recent advances in energy storage and switching technologies now make possible the application of DNA pulsed power technology to such areas as armor/anti-armor; electromagnetic/electrothermal guns; mine-countermine; air, surface, and subsurface systems; high power microwave weapons; etc. Concepts for new applications of pulsed power should be highly innovative and make full use of the emerging pulse power technology.

During Phase I, demonstrate the feasibility of the proposed concept.

During Phase II, develop, test,and evaluate proof-of-principle hardware.

COMMERCIAL POTENTIAL: Compact power devices to clean up smoke stack effluents and environmental pollution control, metal cutting and electric vehicles.

REFERENCES:
(1) Pulsed Power Symposium
(2) EML Symposium

DNA 96-016 TITLE: Directed Energy Effects

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Investigate the effects of directed energy and develop survivability technologies to mitigate these effects.

DESCRIPTION: The effects of directed energy sources such as lasers, neutral particle beams and charged particle beams on materials, structures and systems are of interest to DNA. Of particular interest are the establishment of the correlation between nuclear weapons effects and directed energy effects, the identification of materials which are capable of withstanding both nuclear weapons effects and directed energy effects, and the interaction mechanisms of directed energy sources actually interact with target materials/structures.

During Phase I, demonstrate the feasibility of the proposed investigation.

During Phase II, characterize the effects of directed energy on materials, structures, etc.

COMMERCIAL POTENTIAL: High energy welding.

DNA 96-017 TITLE: Forecasting Environments in the Troposphere and Space(FORETS)

CATEGORY: Exploratory Development, Environment Effects

OBJECTIVE: To investigate the effects of the natural and disturbed environments on atmospheric and space forecasting methods. Develop techniques to mitigate these effects, account for physical processes contributing to chaotic environments, and improve performance predictions.

DESCRIPTION: The Defense Nuclear Agency (DNA) is interested in the basic physical process which describes the effects of the natural and disturbed environment on the employment of various weapon systems. These environments may create situations that degrade the propagation of communication and radar signals, optical sensor systems, and weapon system employment. Part of DNA's mission is to predict effects the environment will have on these systems. Areas of interest include development of models and model predictions to forecast the effects of clouds on the theater of operations; the identification and streamlining of a model for support of theater operation; the development of a coupled space weather model to predict particle fluences and spectra; and the development of cloud and scintillation climatologies.

During Phase I, demonstrate the feasibility of the proposed areas of investigation to advance the understanding in any one of the areas.

During Phase II, continue the investigation leading to the development of models/products that can be incorporated into the existing technology base.

COMMERCIAL POTENTIAL: Weather prediction.

REFERENCES:

(1) Journal of Atmospheric Sciences
(2) Journal of Geophysical Review
(3) Radio Science
(4) Weather Review

DNA 96-018 TITLE: Advanced Lethality Technologies

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Demonstrate innovative applications of advanced non-nuclear technologies for enhanced target lethality or nuclear effects simulations.

DESCRIPTION: Of interest to DNA is the development and demonstration of capabilities which may significantly extend weapons range-to-effect or enhance lethality against hard targets. The response of a hardened bunker complex or of intrinsically hard ballistic missile sub-munition warhead payloads are of particular interest. Novel applications of explosives technology, hyperkinetic technologies, or directed energy (DE) concepts will be of interest.

During Phase I the research will develop concept feasibility through either analysis or laboratory scale demonstration.

During Phase II, the concepts will be further developed through more definitive experiments and/or sophisticated computational analyses.

COMMERCIAL POTENTIAL: Hypervelocity, advanced explosives.

DNA 96-019 TITLE: Field Expedient Hardening

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop innovative methods that would temporarily harden military and civilian equipment to nuclear weapon effects.

DESCRIPTION: Innovative methods to temporarily harden military and essential civilian equipment to the effects of nuclear weapons are of interest. Installation should be relatively easy and quick (hours to a few days) and provide protection for several months to a year. Such hardening methods must be practical for field equipment and allow operation of the system.

During Phase I the research will develop concept feasibility through either analysis or laboratory scale demonstration.

During Phase II, the concepts will be further developed through more definitive experiments and/or field demonstrations.

COMMERCIAL POTENTIAL: Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) protection, lightning protection.

REFERENCES:

(1) Mil-Std-188-125
(2) Mil-Hdbk-423
(3) DNA EM-1, Capabilities of Nuclear Weapons
(4) Glasstone, The Effects of Nuclear Weapons

DNA 96-020 TITLE: Fault Detection, Packaging and Testing

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Improve the testing capability which stress operation or functional testing of densely packed systems and subsystems.

DESCRIPTION: The ability to test densely packaged systems and subsystems requires the development of new test vectors and a new screening process prior to testing at a radiation test facility. The objective of this topic is to develop and demonstrate innovative software and hardware that will: 1) ensure worst case stressing while testing in radiation or other hostile environments; 2) improve the fault detection with location of fault; 3) improve exercising software; and 4) improve low noise testing for high upset package parts in multichip modules or high density packaged circuits.

During Phase I the research will develop the feasibility of the proposed technology, methods, and concepts.

During Phase II, the research concepts developed in Phase I will be demonstrated or reduced to engineering practices.

COMMERCIAL POTENTIAL: Satellites, Information Highway.

DNA 96-021 TITLE: Advanced Space Nuclear Power and Propulsion Technology

CATEGORY: Exploratory Development, Propulsion and Energy Conversion

OBJECTIVE: Demonstrate innovative approaches to space power and propulsion technologies that use space nuclear reactors as the power source. Nuclear fuel technology is excluded from this effort.

DESCRIPTION: The Defense Nuclear Agency (DNA) is interested in the development and demonstration of capabilities that extend the maturity of the U.S. space nuclear power and propulsion technology base. Technologies supporting power-only, propulsion-only, and
bi-modal (power+propulsion) are of interest. Particular interest for power technologies is in static conversion processes. System level research is not included in this effort, nor is nuclear fuel technology.

During Phase I, the research will develop material, component, or subcomponent feasibility through analysis or laboratory scale demonstrations.

During Phase II, material, component or subcomponent will be further developed through more definitive experiments,

analysis and/or life testing.

COMMERCIAL POTENTIAL: Supports high-powered (> 10 kWe) satellites, Space-Tug concepts, Launch Vehicle Step-downs for massive satellites.

DNA 96-022 TITLE: Nuclear Weapon System Safety Assessments

CATEGORY: Exploratory Development, Nuclear Related Technologies

OBJECTIVE: Improved safety of US nuclear weapons

DESCRIPTION: Quantifying, reducing, and managing the risks associated with the life-cycle management of US nuclear weapons is of vital importance. New and innovative concepts to improve on traditional probabilistic risk assessment techniques and methodologies, as well as operations are desired to increase the overall safety of these assets. Abnormal environments that may be encountered include mechanical insults (e.g., drops, vehicle accidents), thermal insults (e.g., fuel fires), electrical insults (e.g., lightning, electrical power), and combinations of these environments. Long range program thrusts include characterizing these abnormal environments, analyzing human factors and developing quick running models to allow decision makers to manage safety risks. Concepts should employ innovative ideas and make use of new and emerging technologies. Work will include measurement improvements, risk reduction techniques, and advanced algorithms for improved quick-look capabilities.

Measures to improve the safety of nuclear weapons against all possible abnormal environments are required. Safety enhancement measures include prediction of events through characterization of initiators and eliminating/mitigating such initiators. Proposals should describe how they will improve protection against known and predicted risks and should emphasize risk elimination/reduction where appropriate.

During Phase I, demonstrate the feasibility and potential usefulness of the proposed safety technologies/techniques.

During Phase II, fully develop the proposed technologies/techniques so they can be compared to existing techniques.

COMMERCIAL POTENTIAL: Data risk assessment and management models potential for adaptation to a variety of users. Risk models can be used in evaluating manufacturing alternatives, optimizing safety budgets and equipment, to reducing risks in the home or comparing potential alternate decisions.

REFERENCES:
(1) Joint DoD/DOE Surety Plan, August 1991
(2) Report of the Panel on Nuclear Weapons Safety, December 1990

BALLISTIC MISSILE DEFENSE ORGANIZATION (BMDO)
SMALL BUSINESS INNOVATION RESEARCH PROGRAM
Submitting Proposals

Send Phase I proposals (five copies of the full proposal, PLUS one copy of Appendices A and B only) by US mail to:

Ballistic Missile Defense Organization
Attn: TRI/SBIR
7100 Defense, Pentagon
Washington, D.C. 20301-7100

For Administrative Help ONLY: Call 800-937-3150
Electronic Access: 800-WIN-BMDO (BBS)
http://www.futron.com/bmdo/sbir.html (A Home Page/World-Wide-Web)

Proposals delivered by other means (commercial delivery service or handcarry) must be delivered to Room 1D110, The Pentagon, Washington, D.C. **WARNING: Only persons with access to the interior of the Pentagon building can reach Room 1D110. Delivery to a Pentagon entrance is not sufficient**. (NOTE: Only a few courier services have access to the Pentagon.) BMDO will acknowledge receipt of proposals only if the proposal includes a self-addressed stamped envelope and a form (like Reference B) that needs only a signature by BMDO.

BMDO seeks the most innovative technology that might enable a defense against a missile in flight - lighter, faster, smarter, more reliable components. Proposers need not know details of possible BMDO systems.

BMDO seeks to invest seed-capital, <u>to supplement private capital</u>, in a product with a future market potential (preferably private sector) and a measurable BMDO benefit. BMDO SBIR will not further develop concepts **already mature enough to compete** for private capital or for government development funds. Phase I will show the concept feasibility and the merit of a Phase II for a prototype or at least a proof-of-principle. Phase I proposals will be judged mostly on degree of technology innovation. Phase II competition will also be judged intensely on future market potential. Phase II proposals may be submitted anytime after Phase I starts. Projects showing time sensitivity will be considered for Phase II start-up funding and Phase I proposals may include a post-Phase I optional task that will permit rapid start-up <u>if Phase II is approved.</u> Principal Investigators who are tenured faculty are <u>not</u> considered primarily employed by a small firm if they receive compensation from the university while performing the SBIR contract; any waiver must be requested explicitly with a justification showing a compelling national need; BMDO expects to grant <u>no</u> waivers.

BMDO intends Phase I to be only an examination of the merit of the concept with an average cost under $60,000. Although proposed cost will **<u>not</u>** affect selection for negotiation, contracting may be delayed if BMDO reduces the cost ceiling. Do not submit the same proposal (or variations) to more than one topic; each idea will be judged once in an open topic-blind competition among all proposals.

Because BMDO seeks the best nation-wide experts in innovative technology, proposers may suggest technical government reviewers by enclosing a cover letter with the name, organization, address and phone number (if known), and a rationale for each suggestion. BMDO promises only to consider the suggestion.

BALLISTIC MISSILE DEFENSE ORGANIZATION TOPICS

BMDO96-001	Directed Energy Concepts
BMDO96-002	Kinetic Energy Weapons
BMDO96-003	Sensors
BMDO96-004	Unit Cost Reduction
BMDO96-005	Non-Nuclear Power and Power Conditioning
BMDO96-006	Propulsion and Logistics
BMDO96-007	Thermal Management
BMDO96-008	Survivability
BMDO96-009	Lethality
BMDO96-010	Computer Architecture, Algorithms, and Language
BMDO96-011	Optical Computing and Optical Signal Processing
BMDO96-012	Structural Concepts
BMDO96-013	Structural Materials
BMDO96-014	Electronic Materials
BMDO96-015	Superconductive Materials
BMDO96-016	Surprises and Opportunities

BMDO TOPIC DESCRIPTIONS

BMDO96-001 TITLE: **Directed Energy Concepts**

DESCRIPTION: Innovative applied research in the generation and propagation of directed energy beams. Systems being considered include (but are not limited to) chemical lasers, excimer lasers, laboratory x-ray lasers, gamma-ray lasers, solid-state free electron lasers, and hybrid approaches. Included are such topics as weapon pointing, beam control, acquisition, tracking and pointing, mirrors, beam propagation, optics, and countermeasures.

BMDO96-002 TITLE: **Kinetic Energy Weapons**

DESCRIPTION: Kinetic energy (KE) weapons candidates presently include a variety of ground and space based interceptors including their propulsion. System elements include ground-based launchers, axial and divert motors/nozzles, smart projectile components, and endo/exoatmospheric guidance and control mechanisms. Technology challenges for KE systems include: finding the booster hardbody within the plume, high performance axial and divert propulsion sub-systems (especially very low mass divert systems), miniature inertial navigation units, array image processing, C.G. Control algorithms, fast frame multicolor and ultra-violet Seekers, acquisition and track; target discrimination, seeker operational environments, lethality/miss distance; aero-optical effects, guidance and fuzing accuracy, shroud separation, window thermal-structural integrity, non-nuclear kill warhead performance, target acquisition in a nuclear environment, performance and survivability of electronics in nuclear environment; firing rate, projectile guidance and control and projectile launch survivability; and, common among all systems reliability; producibility, safety (non-hazardous operation), maintainability, and low cost/low mass; aeroshell ablation control; electromagnetic launches.

BMDO96-003 TITLE: **Sensors**

DESCRIPTION: Sensors and their associated systems will function as the "eyes and ears" of a space-based ballistic missile defense system, providing early warning of attack, target identification, target tracking, and kill determination. New and innovative approaches to these requirements using unconventional techniques are encouraged across a broad band of the electromagnetic spectrum, from radar to gamma-rays. Passive, active, and interactive techniques for discriminating targets from backgrounds, debris, decoys and other penetration aids are sought. Sensor-related device technology is also needed. Examples of some of the specific areas are: cryogenic coolers (open and closed systems), cryogenic heat transfer, superconducting focal plane detector arrays (for both the IR and sub-mm spectral regions), signal and data processing algorithms (for both conventional focal plane and interferometric imaging systems), low-power optical and sub-mm wave beam steering, range-doppler lidar and radar, passive focal plane imaging (long wavelength infrared to ultra-violet; novel information processing to maximize resolution while minimizing detector element densities) interferometry (both passive and with active illumination), gamma-ray detection, neutron detection, intermediate power frequency agile lasers for diffractive beam steering and remote laser induced emission spectroscopy, lightweight compact efficient fixed frequency radiation sources for space-based BMDO application (uv through sub-mm wave), new optics and optical materials. Entirely new approaches are also sought.

BMDO96-004 TITLE: **Unit Cost Reduction**

DESCRIPTION: BMDO seeks drastically lower unit cost of components through manufacturing revolutions that will lead to high volume production from commercial sales. Thus BMDO will consider proposals that offer such a huge unit cost reduction that a heretofore purely anti-missile military technology would become a high volume commercial item. Whereas all other topics seek first and foremost a revolution in the miliary capability of the technology, this topic seeks only a revolution in the unit cost. BMDO seeks herein only projects that are too risky for ordinary capital investment by the private sector. The proposals must include and will be judged in part on an economic analysis of the expected market impact.

BMDO96-005 TITLE: **Non-Nuclear Power and Power Conditioning**

DESCRIPTION: Non-nuclear approaches are sought for high energy densities. The power duty cycles to be considered include: hundreds of MW power for burst applications, sustained tens of kW to MW power for electric propulsion, continuous tens of W to a few kW for house keeping, communications, etc. Specific topics include novel very long life battery concepts, chemically driven systems for burst power, advanced solar collectors and high efficiency multibandgap or thin film converters, inductive and capacitive stores, heat dissipation systems, signature control, plasma switches, and high temperature power electronics. Also, concepts and systems that improve maintainability and reliability of space power systems (e.g. low loss insulation and cable) are sought. Very light weight and affordable technologies are also sought as are concepts that can work in the van Allen belt, and after high acceleration launch. Power conditioning for terrestrial power (not terrestrial power generation).

BMDO96-006 TITLE: **Propulsion and Logistics**

DESCRIPTION: Missile defense places unprecedented demands on all types of space transportation and propulsion systems; launch to low earth orbit, orbit transfer, orbit maneuvering, and station keeping. In particular, advancements are needed to achieve major reductions in the costs of placing and maintaining payloads in the desired orbit. Approaches leading to techniques, methods, processes, and products in support of these propulsion and logistics objectives are sought. Propulsion approaches include liquid, solid, and electric. Advancements are needed in propulsion-related areas, e.g., extending storage time of cryogenic fluids (e.g. H_2 and Ze), reduction of contamination from effluent, and sensors and controls for autonomous operation. Areas of interest include the entire spectrum of space transportation and support: efficient launch systems for small technological payloads as well as full system payloads, assembly, and control systems; expendable and recoverable components; improved structures and materials; and increased propulsion efficiency. In anticipation of and solar power demonstration missions incorporating electric thrusters, BMDO seeks 10 to 30 kW electric thruster modules (e.g., electrodes, insulators, ignition systems, propellant control, command and control system, thermal management system, and power conditioning unit). With the advent of small surveillance satellites, low power (0.5 to 2 kW) electric propulsion is being considered for station keeping and orbit transfer; for such systems emphasis is being placed on achieving higher power densities for components of the integrated system (thruster, power conditioning unit, fuel control, gimbals, and fuel storage). Low mass interceptors require advances in divert (small thrusters) propulsion systems (either solid or liquid).

BMDO96-007 TITLE: **Thermal Management**

DESCRIPTION: The high power levels for space stations must dissipate heat at state-of-the-art capabilities for waste thermal energy acquisition, transport, and dissipation to space. Technology advancements are required in thermal management for both power generation systems, space platform payloads, and electronics. Some space platforms will require years of storage of large amounts of cryogens with minimum cryogen loss and high cryogen delivery rates under condition of zero-g, concept and devices for all types of space-based power cycles, and can satisfy these projected space platform requirements.

BMDO96-008 TITLE: **Survivability**

DESCRIPTION: Missile defense elements must survive determined attacks against the system, and the natural space environments (atomic oxygen, space radiation and micrometeorites/debris). Survivability technology is needed for threat sensing, creation of false aim points, and passive hardening.

Threat sensors enable the defense elements to detect nuclear, laser and radio frequency weapon attacks, and to respond appropriately. Sensors which can characterize the threat according to direction of attack, and spectral characteristics. Technologies to create false aim points are needed to operate against the threat support sensors, including radar, passive visible/IR sensors and seekers, and laser radar.

Passive hardening against the nuclear, laser, RF and pellet/debris environments is needed, in addition to hardening against the natural space environments. Sensor systems, communications antennas (RF and laser), attitude sensors, solar power, propulsion, structure and thermal control are all directly exposed to nuclear, laser, RF and pellet/debris in addition to the natural space environments. Materials and component designs which are intrinsically hard to these environments, and/or protective

devices are needed. A key area is sensor subsystems, the components of which (baffle materials, mirrors, optics, structures, and focal plane arrays/read out electronics) must survive the laser, nuclear and IR environments. Nuclear and laser hard baffle materials, and devices for protection against unknown or agile lasers and rejection of RF energy. Structures and coatings providing appropriate thermal characteristics, stability under mechanical impulses and hardness to laser and RF radiation are needed. Processors capable of operating in unique nuclear environments presented by the strategic application (i.e. multiple burst environments) while retaining full functionality.

BMDO96-009 TITLE: **Lethality**

DESCRIPTION: A major factor in determining the effectiveness of a ballistic missile defense is the lethality of the directed and kinetic energy devices against responsively hardened targets. New concepts to produce a much higher probability of kill-given-a-hit.

BMDO96-010 TITLE: **Computer Architecture, Algorithms, and Language**

DESCRIPTION: Missile defense systems for battle management demand order-of-magnitude advances. A system must acquire and track thousands of objects with hundreds of networked sensors and data processors, direct weaponry to intercept targets, and determine the degree of kill. Areas of interest are:

- New computer architectures which are robust, compact, and fault-tolerant, but allow for the extremely rapid processing of data. Architectures may be implemented by new designs or innovative applications of existing technologies, such as optical signal processing, systolic arrays, neural networks, etc.

- Very high-level language (VHLL) design for both the development and testing of extremely large software systems.

- Novel numerical algorithms for enhancing the speed of data processing for sensing, discrimination, and systems control. These may be specifically tailored to a particular task (for instance, the execution of a phase retrieval algorithm for interferometric imaging). Includes neural networks.

- Language design to develop code optimized for highly parallel processed architectures.

- Testing techniques that will provide a high level of confidence in the successful operation of concurrent, real-time, distributed large-scale software systems. Examples include sensitivity analysis, data flow testing, mutation testing, static concurrency analysis, and dependency analysis.

- Computer network and communications security. R&D for trusted computer systems in accordance with DoD 5200.28.STD; integration of COMPUSEC with COMSEC (DoD 5200.5).

- Self-adaptive processing and simulation. Algorithms and architectures for advanced decision making.

- Neurocomputing and Man-Machine Interface - rule-based AI and neural networks combined for decision making flexibility and system robustness; development of decision trees and information display for highly automated, short response time, training adaptive high volume scenarios.

- Software architectures for embedded computer networks that especially facilitate incremental system and software integration, hardware and software maintenance, and system evolution, without significant performance degradation.

- Hardware and software self-diagnostic capabilities for monitoring the operational readiness and performance of space and ground systems incorporating embedded computer networks.

- Virtual environments to allow diverse groups to interact in real time an increasingly realistic ways over large distances.

BMDO96-011 TITLE: **Optical Computing and Optical Signal Processing**

DESCRIPTION: Dense computing capability is sought in all architectural variations, from all optic to hybrid computers. Specific examples of areas to be addressed include, but are not limited to, high speed multiplexing, monolithic optoelectronic transmitters, holographic methods, reconfigurable interconnects, optoelectronic circuits, and any other technology contributing to advances in intra-computer communications, optical logic gates, bistable memories, optical transistors, and power limiters. Non-linear optical materials advancements and new bistable optical device configurations.

BMDO96-012 TITLE: **Structural Concepts**

DESCRIPTION: Minimum weight structures are needed to withstand high-g loading, acoustic and thermal environment of ground based interceptors and to provide solid bases for space systems pointing and tracking. Such structures will benefit from : (1) innovative vibration control techniques, (2) innovative fabrication approaches to cut structure cost, and (3) innovative use of advanced materials and/or design approaches to minimize structure weight. For instance, techniques and experimental verification are needed for active and/or passive methods to measure and control vibrations caused by thermo-mechanical flutter, thruster firing or structure borne noise caused by on-board mechanisms. "Active" structural elements containing materials and electronics to provide predictable mechanical displacement in response to applied electrical signals are of interest. Maximization of displacement, mechanical strength, and reliability; parameter stability over extended temperature ranges; and minimization of driving voltage, power, and weight of these elements are desired. Producibility improvements for curved actuator elements, flextensional, and other integrated motion amplifiers are of interest. Fabrication approaches that provide minimum weight with reduced assembly, inspection, and scrap rates for conventional, advanced composite, and "active" structures are needed to reduce costs. Of course, clever design and material usage to reduce structure weight while maintaining or increasing capability are always desirable goals.

BMDO96-013 TITLE: **Structural Materials**

DESCRIPTION: Many of the anticipated structural advances sought in Topic 96-012 will depend on major improvements in material properties and cost effectiveness. Space structures supporting seekers and antenna must accommodate retargeting maneuvers without detrimental jitter from vibrations and thermo-mechanical flutter. Surface launched interceptors must withstand high g loads, aerothermal heating and structural vibration without compromising tracking accuracy. Lightweight materials are very beneficial for both ground and spaced based systems.

Specific goals require advanced techniques and processes that include imparting oxidation resistance and damage tolerance to composites and creating high elastic modulus composites for use over a broad range of temperatures. The following are sought: (1) innovative manufacturing methods for producing high modulus, fiber-reinforced glass, light metal (i.e., aluminum or magnesium), or resin matrix composites; (2) innovative procedures for the production of instrumentation, sensors and software for on-line process monitoring and evaluation of high modulus, fiber-reinforced composites during fabrication; (3) novel approaches to tailor fiber/matrix interfaces to maximize capability in advanced composites; (4) novel methods to cut fabrication cost of metallic and/or composite spacecraft and interceptor structures; (5) innovative tooling techniques for near-net shape production of advanced composites; (6) novel low-to-no outgassing joining/bonding techniques for advanced composites; (7) innovative surface modifications to promote wear resistance; (8) new methods for integrating instrumentation (e.g., embedded sensors) into advanced composite materials and structures; and (9) novel instrumentation for determination and telemetry of material properties and data from space. Advances are also sought in materials for optical system components, mechanical moving assemblies, and protective coatings.

BMDO96-014 TITLE: **Electronic Materials**

DESCRIPTION: The necessary advances in electronics for the many missile defense applications will require advances in electronics materials.. Primary emphasis lies in advancing the capability of integrated circuits, detectors, sensors, large scale integration, radiation hardness, and all electronic components. Novel quantum-well/superlattice structures which allow the realization of unique elective properties through "band gap engineering" are sought as are new organic and polymer materials with interesting electronic characteristics. In addition, exploitation of the unique electronic properties of single crystal diamond is of considerable interest. Among the many BMDO electronic needs are advances in high frequency transistor structures, solid

state lasers, optical detectors, low dielectric constant packaging materials, tailored thermal conductivity, microstructural waveguides, multilayer capacitors, metallization methods for repair of conducting paths in polyceramic systems, and sol-gel processing for packaging materials.

BMDO96-015 TITLE: **Superconductive Materials**

DESCRIPTION: BMDO wants to demonstrate both high temperature superconductor (HTS) and low temperature superconductor (LTS) devices to enable or improve strategic defenses. Emphasis in HTS technology is in components integrated with state-of-the-art cryoelectronics for communications systems at K- and V- bands and radar systems in the X-band power and inductive energy storage. The demonstration of HTS materials to BLIP limited detection of radiation in the optical, IR, MWIR, and LWIR bands as well as for signal processing applications is also of interest. The emphasis in LTS technology is the development and demonstration of high sensitivity detectors, digital electronics and memory enabling on-focal plane array signal processing and operating at temperature greater than 10K. Efforts should address packaging and interface issues and systems integration with cryocoolers and stored cryogens.

BMDO96-016 TITLE: **Surprises and Opportunities**

DESCRIPTION: Since BMDO is an exploration at technology's leading edge, it recognizes that surprises and opportunities may arise from creative minds. BMDO will consider proposals in other technologies where they present an unusual opportunity for BMD. The proposer should take special care to describe the technology and why BMDO would benefit from exploring it. Proposers should note that proposals in this topic will receive preliminary screening that may reject them as too far afield without the full technical review received by proposals in the topics already listed. This open call is for new technology, not for recycling of old ideas.

9.0 SUBMISSION FORMS AND CERTIFICATIONS

Section 9.0 contains:

Appendix A: **Proposal Cover Sheet**
An original red-printed Appendix A must be included with each proposal submitted.

Appendix B: **Project Summary Form**
An original red-printed Appendix B must be included with each proposal submitted. Don't include proprietary or classified information in the project summary form.

Appendix C: **Cost Proposal Outline**
A cost proposal following the format in Appendix C must be included with each proposal submitted.

Appendix D: **Fast Track Application Form**
A new DoD pilot program that provides interim funding and speeds Phase II award process for projects that attract third party funding.

Reference A: **Proposal Receipt Notification Form**

Reference B: **DTIC Information Request Form**

Reference C: **Directory of Small Business Specialists**

Reference D: **SF 298 Report Documentation Page**

Reference E: **DoD SBIR/STTR Mailing List Form**

APPENDIX A

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to use a RED Copy as the original for each proposal and to fill in all appropriate spaces may cause your proposal to be disqualified

TOPIC NUMBER: ______________________

PROPOSALTITLE: ______________________

____

FIRM NAME: ______________________

MAILADDRESS: ______________________

____

CITY: ______________________ STATE: __________ ZIP: __________

PROPOSED COST: ______________________ PHASE I OR II: _____ PROPOSAL PROPOSED DURATION: _____ IN MONTHS

BUSINESS CERTIFICATION:

	YES	NO
▸ Are you a small business as described in paragraph 2.2?	☐	☐
▸ Are you a minority or small disadvantaged business as defined in paragraph 2.3? (Collected for statistical purposes only)	☐	☐
▸ Are you a woman-owned small business as described in paragraph 2.4? (Collected for statistical purposes only)	☐	☐
▸ Have you submitted proposals or received awards containing a significant amount of essentially equivalent work under other DoD or federal program solicitations? If yes, list the name(s) of the agency or DoD component, submission date, and Topic Number in the spaces below.	☐	☐

______________________ ______________________

______________________ ______________________

▸ Number of employees including all affiliates (average for preceding 12 months): ______________________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME: ______________________	NAME: ______________________
TITLE: ______________________	TITLE: ______________________
TELEPHONE: ______________________	TELEPHONE: ______________________

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARINFORMATION: ______________________

______________________	__________	______________________	__________
SIGNATURE OF PRINCIPAL INVESTIGATOR	DATE	SIGNATURE OF CORPORATE BUSINESS OFFICIAL	DATE

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

DOD Components employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed without proportional spacing using one of the following typestyles:

Courier 12,10 or 12 pitch
Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and SUBMIT THE ORIGINAL RED FORMS bound in this solicitation (not photocopies) as page 1 and 2 of the original copy of each proposal. The completed forms can then be copied for use as pages 1 and 2 of the photocopies of the proposal. The original proposal (with red forms) plus (4) complete copies must be submitted (see Section 6).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

Additional red forms may be obtained from your State SBIR Organization (Reference D) or:

Defense Technical Information Center
ATTN: DTIC-SBIR
8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218
(800) 363-7247 (800 DOD-SBIR)

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to use a RED Copy as the original for each proposal and to fill in all appropriate spaces may cause your proposal to be disqualified

TOPIC NUMBER: ____________________

PROPOSALTITLE: ____

____

FIRM NAME: ____

PHASE I or II PROPOSAL: __________

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development.

List a maximum of 8 Key Words that describe the Project.

____________________ ____________________

____________________ ____________________

____________________ ____________________

____________________ ____________________

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

DOD Components employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed <u>without proportional spacing</u> using one of the following typestyles:

Courier 12,10 or 12 pitch
Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and <u>SUBMIT THE ORIGINAL RED FORMS</u> bound in this solicitation (not photocopies) as page 1 and 2 of the <u>original copy</u> of each proposal. The completed forms can then be copied for use as pages 1 and 2 of the photocopies of the proposal. The original proposal (with red forms) plus (4) complete copies must be submitted (see Section 6).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

Additional red forms may be obtained from your State SBIR Organization (Reference D) or:

Defense Technical Information Center
ATTN: DTIC-SBIR
8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218
(800) 363-7247 (800 DOD-SBIR)

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
COST PROPOSAL

Background:

The following items, as appropriate, should be included in proposals responsive to the DoD Solicitation Brochure.

Cost Breakdown Items (in this order, as appropriate):

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DoD Solicitation Brochure
6. Total dollar amount of the proposal
7. Direct material costs
    a. Purchased parts (dollars)
    b. Subcontracted items (dollars)
    c. Other
        (1) Raw material (dollars)
        (2) Your standard commercial items (dollars)
        (3) Interdivisional transfers (at other than cost dollars)
    d. Total direct material (dollars)
8. Material overhead (rate_____%) x total direct material = dollars
9. Direct labor (specify)
    a. Type of labor, estimated hours, rate per hour and dollar cost for each type
    b. Total estimated direct labor (dollars)
10. Labor overhead
    a. Identify overhead rate, the hour base and dollar cost
    b. Total estimated labor overhead (dollars)
11. Special testing (include field work at government installations)
    a. Provide dollar cost for each item of special testing
    b. Estimated total special testing (dollars)
12. Special equipment
    a. If direct charge, specify each item and cost of each
    b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
    a. Transportation (detailed breakdown and dollars)
    b. Per diem or subsistence (details and dollars)
    c. Estimated total travel (dollars)
14. Consultants
    a. Identify each, with purpose, and dollar rates
    b. Total estimated consultants costs (dollars)
15. Other direct costs (specify)
    a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
    a. Percentage rate applied
    b. Total estimated cost of G&A expense (dollars)
17. Royalties (specify)
    a. Estimated cost (dollars)
18. Fee or profit (dollars
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
    a. Has any executive agency of the United State Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone extension.
    b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
    c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-fee or firm-fixed price.

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
FAST TRACK APPLICATION FORM

Failure to fill in all appropriate spaces may cause your application to be disqualified

FAST TRACK PROGRAM QUALIFICATIONS (see Section 4.5 of the solicitation for detailed explanation)
To qualify for the SBIR Fast-Track, a company must submit the following items, within 120 days after the start of its Phase I project, to the same address the company would send its Phase II proposal (see back):

(1) This application form, completed (please also send a copy to OSD SBIR -- see back);
(2) A commitment letter from an independent third-party investor indicating that the third-party investor will match both interim and Phase II SBIR funding, in cash, at the matching rate noted below (under Business Certification);
(3) A concise statement of work for the Interim SBIR effort (if an interim option was not negotiated on the Phase I contract) -- under 4 pages in length;
(4) A concise report on the status of the Phase I project (if required by the DoD component that is funding the project) -- under 4 pages in length;

In addition:

(1) The company must submit its Phase II proposal no later than 30 days prior to completion of its Phase I project (unless a different deadline for submission of fast-track Phase II proposals is specified in the Phase II proposal instructions of the sponsoring DoD component).
(2) If the company receives an interim and/or Phase II SBIR award from DoD, its matching funds must arrive before corresponding installments of SBIR funds are released (see Section 4.5 for explanation)

TOPIC #: ________ CONTRACT #: ________ PHASE I COMPLETION DATE: ________

PHASE I TITLE: ________________________________

____

FIRM NAME: ________________________________

MAIL ADDRESS: ________________________________

____

CITY: ________ STATE: ________ ZIP: ________

BUSINESS CERTIFICATION:

	YES	NO	MATCHING RATE
▸ Do you have 10 or fewer employees and have never received a Phase II SBIR award from the federal government (including DoD)? (If YES, the minimum Third Party matching rate is 25 cents for every SBIR dollar)	☐	☐	25¢:$1 ☐
▸ Have you received 5 or more Phase II SBIR awards from the federal government (including DoD)? (If YES, the minimum Third Party matching rate is $1 for every SBIR dollar)	☐	☐	$1:$1 ☐
If you answered NO to both questions, the minimum Third Party matching rate is 50 cents for every SBIR dollar.			50¢:$1 ☐

DOD SBIR AGENCY: ________ THIRD PARTY: ________

PROPOSED INTERIM COST: ________ 3RD PARTY INTERIM FUNDING: ________

PROPOSED PHASE II COST: ________ 3RD PARTY PHASE II FUNDING: ________

FIRM CORPORATE OFFICIAL	THIRD PARTY CORPORATE OFFICIAL
NAME: ________	NAME: ________
TITLE: ________	TITLE: ________
TELEPHONE: ________	TELEPHONE: ________

________ SIGNATURE OF FIRM CORPORATE OFFICIAL ________ DATE ________ SIGNATURE OF THIRD PARTY CORPORATE OFFICIAL ________ DATE

INSTRUCTIONS FOR COMPLETING APPENDIX D

General:

The Fast Track Application Form (Appendix D) should be typed in either a 10 or 12 characters per inch font.

Carefully align the forms in the typewriter using the underlines as a guide.

When typing address information use the two alphabet characters used by the Post Office for the state (i.e. type NY not New York).

Submission:

Submit all items to the same address you would send your Phase II proposal. This will be listed in the Phase II proposal instructions sent to you at the start of your Phase I project. (If you do not yet have the Phase II proposal instructions, please contact your DoD contracting officer.)

Also, please send a copy of this application form, when completed, to OSD SBIR, 3061 Defense Pentagon, Room 2A338, Washington, DC 20301-3061. Do not submit other items to OSD SBIR.

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to use a RED Copy as the original for each proposal and to fill in all appropriate spaces may cause your proposal to be disqualified

TOPIC NUMBER: ______________________

PROPOSALTITLE: ____

____

FIRM NAME: ____

MAILADDRESS: ____

____

CITY: ______________________ STATE: __________ ZIP: __________

PROPOSED COST: ______________ PHASE I OR II: _____ PROPOSAL PROPOSED DURATION: _____ IN MONTHS

BUSINESS CERTIFICATION:	YES	NO
► Are you a small business as described in paragraph 2.2?	☐	☐
► Are you a minority or small disadvantaged business as defined in paragraph 2.3? (Collected for statistical purposes only)	☐	☐
► Are you a woman-owned small business as described in paragraph 2.4? (Collected for statistical purposes only)	☐	☐
► Have you submitted proposals or received awards containing a significant amount of essentially equivalent work under other DoD or federal program solicitations? If yes, list the name(s) of the agency or DoD component, submission date, and Topic Number in the spaces below.	☐	☐

______________________ ______________________

______________________ ______________________

► Number of employees including all affiliates (average for preceding 12 months): ______________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME: ______________	NAME: ______________
TITLE: ______________	TITLE: ______________
TELEPHONE: ______________	TELEPHONE: ______________

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARYINFORMATION: ____

______________	______	______________	______
SIGNATURE OF PRINCIPAL INVESTIGATOR	DATE	SIGNATURE OF CORPORATE BUSINESS OFFICIAL	DATE

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

DOD Components employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed without proportional spacing using one of the following typestyles:

Courier 12,10 or 12 pitch
Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and SUBMIT THE ORIGINAL RED FORMS bound in this solicitation (not photocopies) as page 1 and 2 of the original copy of each proposal. The completed forms can then be copied for use as pages 1 and 2 of the photocopies of the proposal. The original proposal (with red forms) plus (4) complete copies must be submitted (see Section 6).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

Additional red forms may be obtained from your State SBIR Organization (Reference D) or:

Defense Technical Information Center
ATTN: DTIC-SBIR
8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218
(800) 363-7247 (800 DOD-SBIR)

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to use a RED Copy as the original for each proposal and to fill in all appropriate spaces may cause your proposal to be disqualified

TOPIC NUMBER: ______________________

PROPOSALTITLE: ____

____

FIRM NAME: ____

PHASE I or II PROPOSAL: __________

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development.

List a maximum of 8 Key Words that describe the Project.

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

DOD Components employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed without proportional spacing using one of the following typestyles:

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Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

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Complete and SUBMIT THE ORIGINAL RED FORMS bound in this solicitation (not photocopies) as page 1 and 2 of the original copy of each proposal. The completed forms can then be copied for use as pages 1 and 2 of the photocopies of the proposal. The original proposal (with red forms) plus (4) complete copies must be submitted (see Section 6).

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Ft. Belvoir, VA 22060-6218
(800) 363-7247 (800 DOD-SBIR)

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
COST PROPOSAL

Background:

The following items, as appropriate, should be included in proposals responsive to the DoD Solicitation Brochure.

Cost Breakdown Items (in this order, as appropriate):

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DoD Solicitation Brochure
6. Total dollar amount of the proposal
7. Direct material costs
   a. Purchased parts (dollars)
   b. Subcontracted items (dollars)
   c. Other
      (1) Raw material (dollars)
      (2) Your standard commercial items (dollars)
      (3) Interdivisional transfers (at other than cost dollars)
   d. Total direct material (dollars)
8. Material overhead (rate_____%) x total direct material = dollars
9. Direct labor (specify)
   a. Type of labor, estimated hours, rate per hour and dollar cost for each type
   b. Total estimated direct labor (dollars)
10. Labor overhead
   a. Identify overhead rate, the hour base and dollar cost
   b. Total estimated labor overhead (dollars)
11. Special testing (include field work at government installations)
   a. Provide dollar cost for each item of special testing
   b. Estimated total special testing (dollars)
12. Special equipment
   a. If direct charge, specify each item and cost of each
   b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
   a. Transportation (detailed breakdown and dollars)
   b. Per diem or subsistence (details and dollars)
   c. Estimated total travel (dollars)
14. Consultants
   a. Identify each, with purpose, and dollar rates
   b. Total estimated consultants costs (dollars)
15. Other direct costs (specify)
   a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
   a. Percentage rate applied
   b. Total estimated cost of G&A expense (dollars)
17. Royalties (specify)
   a. Estimated cost (dollars)
18. Fee or profit (dollars
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
   a. Has any executive agency of the United State Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone extension.
   b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
   c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-fee or firm-fixed price.

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
FAST TRACK APPLICATION FORM

Failure to fill in all appropriate spaces may cause your application to be disqualified

FAST TRACK PROGRAM QUALIFICATIONS (see Section 4.5 of the solicitation for detailed explanation)
To qualify for the SBIR Fast-Track, a company must submit the following items, within 120 days after the start of its Phase I project, to the same address the company would send its Phase II proposal (see back):

(1) This application form, completed (please also send a copy to OSD SBIR -- see back);
(2) A commitment letter from an independent third-party investor indicating that the third-party investor will match both interim and Phase II SBIR funding, in cash, at the matching rate noted below (under Business Certification);
(3) A concise statement of work for the Interim SBIR effort (if an interim option was not negotiated on the Phase I contract) -- under 4 pages in length;
(4) A concise report on the status of the Phase I project (if required by the DoD component that is funding the project) -- under 4 pages in length;

In addition:

(1) The company must submit its Phase II proposal no later than 30 days prior to completion of its Phase I project (unless a different deadline for submission of fast-track Phase II proposals is specified in the Phase II proposal instructions of the sponsoring DoD component).
(2) If the company receives an interim and/or Phase II SBIR award from DoD, its matching funds must arrive before corresponding installments of SBIR funds are released (see Section 4.5 for explanation)

TOPIC #: ________ CONTRACT #: ________ PHASE I COMPLETION DATE: ________

PHASE I TITLE: ________

____

FIRM NAME: ________

MAIL ADDRESS: ________

____

CITY: ________ STATE: ________ ZIP: ________

BUSINESS CERTIFICATION:

	YES	NO	MATCHING RATE
▸ Do you have 10 or fewer employees and have never received a Phase II SBIR award from the federal government (including DoD)? (If YES, the minimum Third Party matching rate is 25 cents for every SBIR dollar)	☐	☐	25¢:$1 ☐
▸ Have you received 5 or more Phase II SBIR awards from the federal government (including DoD)? (If YES, the minimum Third Party matching rate is $1 for every SBIR dollar)	☐	☐	$1:$1 ☐
If you answered NO to both questions, the minimum Third Party matching rate is 50 cents for every SBIR dollar.			50¢:$1 ☐

DOD SBIR AGENCY: ________ THIRD PARTY: ________

PROPOSED INTERIM COST: ________ 3RD PARTY INTERIM FUNDING: ________

PROPOSED PHASE II COST: ________ 3RD PARTY PHASE II FUNDING: ________

FIRM CORPORATE OFFICIAL	THIRD PARTY CORPORATE OFFICIAL
NAME: ________	NAME: ________
TITLE: ________	TITLE: ________
TELEPHONE: ________	TELEPHONE: ________

________ SIGNATURE OF FIRM CORPORATE OFFICIAL ________ DATE ________ SIGNATURE OF THIRD PARTY CORPORATE OFFICIAL ________ DATE

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX D

General:

The Fast Track Application Form (Appendix D) should be typed in either a 10 or 12 characters per inch font.

Carefully align the forms in the typewriter using the underlines as a guide.

When typing address information use the two alphabet characters used by the Post Office for the state (i.e. type NY not New York).

Submission:

Submit all items to the same address you would send your Phase II proposal. This will be listed in the Phase II proposal instructions sent to you at the start of your Phase I project. (If you do not yet have the Phase II proposal instructions, please contact your DoD contracting officer.)

Also, please send a copy of this application form, when completed, to OSD SBIR, 3061 Defense Pentagon, Room 2A338, Washington, DC 20301-3061. Do not submit other items to OSD SBIR.

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to use a RED Copy as the original for each proposal and to fill in all appropriate spaces may cause your proposal to be disqualified

TOPIC NUMBER: ______________________

PROPOSALTITLE: ______________________

____

FIRM NAME: ______________________

MAILADDRESS: ______________________

____

CITY: ______________________ STATE: __________ ZIP: __________

PROPOSED COST: ______________________ PHASE I OR II: _____ PROPOSAL PROPOSED DURATION: _____ IN MONTHS

BUSINESS CERTIFICATION:

	YES	NO
▸ Are you a small business as described in paragraph 2.2?	☐	☐
▸ Are you a minority or small disadvantaged business as defined in paragraph 2.3? (Collected for statistical purposes only)	☐	☐
▸ Are you a woman-owned small business as described in paragraph 2.4? (Collected for statistical purposes only)	☐	☐
▸ Have you submitted proposals or received awards containing a significant amount of essentially equivalent work under other DoD or federal program solicitations? If yes, list the name(s) of the agency or DoD component, submission date, and Topic Number in the spaces below.	☐	☐

______________________ ______________________

______________________ ______________________

▸ Number of employees including all affiliates (average for preceding 12 months): ______________________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME: ______________________	NAME: ______________________
TITLE: ______________________	TITLE: ______________________
TELEPHONE: ______________________	TELEPHONE: ______________________

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARY INFORMATION: ______________________

______________________ ______ ______________________ ______

SIGNATURE OF PRINCIPAL INVESTIGATOR DATE SIGNATURE OF CORPORATE BUSINESS OFFICIAL DATE

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

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Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
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When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

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Ft. Belvoir, VA 22060-6218
(800) 363-7247 (800 DOD-SBIR)

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to use a RED Copy as the original for each proposal and to fill in all appropriate spaces may cause your proposal to be disqualified

TOPIC NUMBER: ______________________

PROPOSALTITLE: ____

____

FIRM NAME: ____

PHASE I or II PROPOSAL: __________

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development.

List a maximum of 8 Key Words that describe the Project.

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

DOD Components employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed <u>without proportional spacing</u> using one of the following typestyles:

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Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
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8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218
(800) 363-7247 (800 DOD-SBIR)

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
COST PROPOSAL

Background:
The following items, as appropriate, should be included in proposals responsive to the DoD Solicitation Brochure.

Cost Breakdown Items (in this order, as appropriate):

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DoD Solicitation Brochure
6. Total dollar amount of the proposal
7. Direct material costs
   a. Purchased parts (dollars)
   b. Subcontracted items (dollars)
   c. Other
      (1) Raw material (dollars)
      (2) Your standard commercial items (dollars)
      (3) Interdivisional transfers (at other than cost dollars)
   d. Total direct material (dollars)
8. Material overhead (rate_____%) x total direct material = dollars
9. Direct labor (specify)
   a. Type of labor, estimated hours, rate per hour and dollar cost for each type
   b. Total estimated direct labor (dollars)
10. Labor overhead
    a. Identify overhead rate, the hour base and dollar cost
    b. Total estimated labor overhead (dollars)
11. Special testing (include field work at government installations)
    a. Provide dollar cost for each item of special testing
    b. Estimated total special testing (dollars)
12. Special equipment
    a. If direct charge, specify each item and cost of each
    b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
    a. Transportation (detailed breakdown and dollars)
    b. Per diem or subsistence (details and dollars)
    c. Estimated total travel (dollars)
14. Consultants
    a. Identify each, with purpose, and dollar rates
    b. Total estimated consultants costs (dollars)
15. Other direct costs (specify)
    a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
    a. Percentage rate applied
    b. Total estimated cost of G&A expense (dollars)
17. Royalties (specify)
    a. Estimated cost (dollars)
18. Fee or profit (dollars
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
    a. Has any executive agency of the United State Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone extension.
    b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
    c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-fee or firm-fixed price.

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
FAST TRACK APPLICATION FORM

Failure to fill in all appropriate spaces may cause your application to be disqualified

FAST TRACK PROGRAM QUALIFICATIONS (see Section 4.5 of the solicitation for detailed explanation)

To qualify for the SBIR Fast-Track, a company must submit the following items, within 120 days after the start of its Phase I project, to the same address the company would send its Phase II proposal (see back):

(1) This application form, completed (please also send a copy to OSD SBIR -- see back);

(2) A commitment letter from an independent third-party investor indicating that the third-party investor will match both interim and Phase II SBIR funding, in cash, at the matching rate noted below (under Business Certification);

(3) A concise statement of work for the Interim SBIR effort (if an interim option was not negotiated on the Phase I contract) -- under 4 pages in length;

(4) A concise report on the status of the Phase I project (if required by the DoD component that is funding the project) -- under 4 pages in length;

In addition:

(1) The company must submit its Phase II proposal no later than 30 days prior to completion of its Phase I project (unless a different deadline for submission of fast-track Phase II proposals is specified in the Phase II proposal instructions of the sponsoring DoD component).

(2) If the company receives an interim and/or Phase II SBIR award from DoD, its matching funds must arrive before corresponding installments of SBIR funds are released (see Section 4.5 for explanation)

TOPIC #: ________ CONTRACT #: ________ PHASE I COMPLETION DATE: ________

PHASE I TITLE: ________

____

FIRM NAME: ________

MAIL ADDRESS: ________

____

CITY: ________ STATE: ________ ZIP: ________

BUSINESS CERTIFICATION:

	YES	NO	MATCHING RATE
▸ Do you have 10 or fewer employees and have never received a Phase II SBIR award from the federal government (including DoD)? (If YES, the minimum Third Party matching rate is 25 cents for every SBIR dollar)	☐	☐	25¢:$1 ☐
▸ Have you received 5 or more Phase II SBIR awards from the federal government (including DoD)? (If YES, the minimum Third Party matching rate is $1 for every SBIR dollar)	☐	☐	$1:$1 ☐
If you answered NO to both questions, the minimum Third Party matching rate is 50 cents for every SBIR dollar.			50¢:$1 ☐

DOD SBIR AGENCY: ________ THIRD PARTY: ________

PROPOSED INTERIM COST: ________ 3RD PARTY INTERIM FUNDING: ________

PROPOSED PHASE II COST: ________ 3RD PARTY PHASE II FUNDING: ________

FIRM CORPORATE OFFICIAL

NAME: ________

TITLE: ________

TELEPHONE: ________

THIRD PARTY CORPORATE OFFICIAL

NAME: ________

TITLE: ________

TELEPHONE: ________

________ SIGNATURE OF FIRM CORPORATE OFFICIAL ________ DATE

________ SIGNATURE OF THIRD PARTY CORPORATE OFFICIAL ________ DATE

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX D

General:

The Fast Track Application Form (Appendix D) should be typed in either a 10 or 12 characters per inch font.

Carefully align the forms in the typewriter using the underlines as a guide.

When typing address information use the two alphabet characters used by the Post Office for the state (i.e. type NY not New York).

Submission:

Submit all items to the same address you would send your Phase II proposal. This will be listed in the Phase II proposal instructions sent to you at the start of your Phase I project. (If you do not yet have the Phase II proposal instructions, please contact your DoD contracting officer.)

Also, please send a copy of this application form, when completed, to OSD SBIR, 3061 Defense Pentagon, Room 2A338, Washington, DC 20301-3061. Do not submit other items to OSD SBIR.

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to use a RED Copy as the original for each proposal and to fill in all appropriate spaces may cause your proposal to be disqualified

TOPIC NUMBER: ____________________

PROPOSALTITLE: ____

____

FIRM NAME: ____

MAILADDRESS: ____

____

CITY: ____________________ STATE: ________ ZIP: ________

PROPOSED COST: ____________________ PHASE I OR II: _____ PROPOSAL PROPOSED DURATION: _____ IN MONTHS

BUSINESS CERTIFICATION:

	YES	NO
▸ Are you a small business as described in paragraph 2.2?	☐	☐
▸ Are you a minority or small disadvantaged business as defined in paragraph 2.3? (Collected for statistical purposes only)	☐	☐
▸ Are you a woman-owned small business as described in paragraph 2.4? (Collected for statistical purposes only)	☐	☐
▸ Have you submitted proposals or received awards containing a significant amount of essentially equivalent work under other DoD or federal program solicitations? If yes, list the name(s) of the agency or DoD component, submission date, and Topic Number in the spaces below.	☐	☐

____________________ ____________________

____________________ ____________________

▸ Number of employees including all affiliates (average for preceding 12 months): ____________________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME: ____________________	NAME: ____________________
TITLE: ____________________	TITLE: ____________________
TELEPHONE: ____________________	TELEPHONE: ____________________

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARY INFORMATION: ____

SIGNATURE OF PRINCIPAL INVESTIGATOR	DATE	SIGNATURE OF CORPORATE BUSINESS OFFICIAL	DATE

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

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Ft. Belvoir, VA 22060-6218
(800) 363-7247 (800 DOD-SBIR)

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

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TOPIC NUMBER: ______________________

PROPOSALTITLE: ____

____

FIRM NAME: ____

PHASE I or II PROPOSAL: ________

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development.

List a maximum of 8 Key Words that describe the Project.

________________________ ________________________

________________________ ________________________

________________________ ________________________

________________________ ________________________

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

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(800) 363-7247 (800 DOD-SBIR)

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
COST PROPOSAL

Background:

The following items, as appropriate, should be included in proposals responsive to the DoD Solicitation Brochure.

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2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DoD Solicitation Brochure
6. Total dollar amount of the proposal
7. Direct material costs
   a. Purchased parts (dollars)
   b. Subcontracted items (dollars)
   c. Other
      (1) Raw material (dollars)
      (2) Your standard commercial items (dollars)
      (3) Interdivisional transfers (at other than cost dollars)
   d. Total direct material (dollars)
8. Material overhead (rate_____%) x total direct material = dollars
9. Direct labor (specify)
   a. Type of labor, estimated hours, rate per hour and dollar cost for each type
   b. Total estimated direct labor (dollars)
10. Labor overhead
    a. Identify overhead rate, the hour base and dollar cost
    b. Total estimated labor overhead (dollars)
11. Special testing (include field work at government installations)
    a. Provide dollar cost for each item of special testing
    b. Estimated total special testing (dollars)
12. Special equipment
    a. If direct charge, specify each item and cost of each
    b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
    a. Transportation (detailed breakdown and dollars)
    b. Per diem or subsistence (details and dollars)
    c. Estimated total travel (dollars)
14. Consultants
    a. Identify each, with purpose, and dollar rates
    b. Total estimated consultants costs (dollars)
15. Other direct costs (specify)
    a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
    a. Percentage rate applied
    b. Total estimated cost of G&A expense (dollars)
17. Royalties (specify)
    a. Estimated cost (dollars)
18. Fee or profit (dollars
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
    a. Has any executive agency of the United State Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone extension.
    b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
    c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-fee or firm-fixed price.

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
FAST TRACK APPLICATION FORM

Failure to fill in all appropriate spaces may cause your application to be disqualified

FAST TRACK PROGRAM QUALIFICATIONS (see Section 4.5 of the solicitation for detailed explanation)
To qualify for the SBIR Fast-Track, a company must submit the following items, within 120 days after the start of its Phase I project, to the same address the company would send its Phase II proposal (see back):

(1) This application form, completed (please also send a copy to OSD SBIR -- see back);
(2) A commitment letter from an independent third-party investor indicating that the third-party investor will match both interim and Phase II SBIR funding, in cash, at the matching rate noted below (under Business Certification);
(3) A concise statement of work for the Interim SBIR effort (if an interim option was not negotiated on the Phase I contract) -- under 4 pages in length;
(4) A concise report on the status of the Phase I project (if required by the DoD component that is funding the project) -- under 4 pages in length;

In addition:

(1) The company must submit its Phase II proposal no later than 30 days prior to completion of its Phase I project (unless a different deadline for submission of fast-track Phase II proposals is specified in the Phase II proposal instructions of the sponsoring DoD component).
(2) If the company receives an interim and/or Phase II SBIR award from DoD, its matching funds must arrive before corresponding installments of SBIR funds are released (see Section 4.5 for explanation)

TOPIC #: ________________ CONTRACT #: ______________________________ PHASE I COMPLETION DATE: ______________

PHASE I TITLE: ____

____

FIRM NAME: ____

MAIL ADDRESS: ____

____

CITY: ____ STATE: __________ ZIP: ____________

BUSINESS CERTIFICATION:

	YES	NO	MATCHING RATE
▸ Do you have 10 or fewer employees and have never received a Phase II SBIR award from the federal government (including DoD)? (If YES, the minimum Third Party matching rate is 25 cents for every SBIR dollar)	☐	☐	25¢:$1 ☐
▸ Have you received 5 or more Phase II SBIR awards from the federal government (including DoD)? (If YES, the minimum Third Party matching rate is $1 for every SBIR dollar)	☐	☐	$1:$1 ☐
If you answered NO to both questions, the minimum Third Party matching rate is 50 cents for every SBIR dollar.			50¢:$1 ☐

DOD SBIR AGENCY: ______________________ THIRD PARTY: ______________________

PROPOSED INTERIM COST: ______________________ 3RD PARTY INTERIM FUNDING: ______________________

PROPOSED PHASE II COST: ______________________ 3RD PARTY PHASE II FUNDING: ______________________

FIRM CORPORATE OFFICIAL	THIRD PARTY CORPORATE OFFICIAL
NAME: ______________________	NAME: ______________________
TITLE: ______________________	TITLE: ______________________
TELEPHONE: ______________________	TELEPHONE: ______________________

______________________________ ________ ______________________________ ________
SIGNATURE OF FIRM CORPORATE OFFICIAL DATE SIGNATURE OF THIRD PARTY CORPORATE OFFICIAL DATE

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX D

General:

The Fast Track Application Form (Appendix D) should be typed in either a 10 or 12 characters per inch font.

Carefully align the forms in the typewriter using the underlines as a guide.

When typing address information use the two alphabet characters used by the Post Office for the state (i.e. type NY not New York).

Submission:

Submit all items to the same address you would send your Phase II proposal. This will be listed in the Phase II proposal instructions sent to you at the start of your Phase I project. (If you do not yet have the Phase II proposal instructions, please contact your DoD contracting officer.)

Also, please send a copy of this application form, when completed, to OSD SBIR, 3061 Defense Pentagon, Room 2A338, Washington, DC 20301-3061. Do not submit other items to OSD SBIR.

TO: ____
Fill in firm's name and mailing address

SUBJECT: SBIR Solicitation No. 96.1
Topic No. ____________
Fill in Topic No.

This is to notify you that your proposal in response to the subject solicitation and topic number has been received by

____
Fill in name of organization to which you will send your proposal.

______________________________ ____________
Signature by receiving organization Date

Reference B
DoD SBIR Solicitation 96.1

To: SBIR Participants

SMALL BUSINESS INNOVATION RESEARCH PROGRAM REQUEST FOR DTIC SERVICES

For assistance in the preparation of informed proposals addressing the topics presented in the DoD SBIR Program Solicitation, you are encouraged to request annotated bibliographies of technical reports from the Defense Technical Information Center (DTIC). The cited reports cover selected prior DoD-funded work in related areas. Reasonable numbers of these reports may be obtained at no cost from DTIC under the SBIR Program. You will also receive information on related work-in-progress, and references to other information resources.

Complete the request form, fold, stamp and mail. Please bear in mind that significant mailing delays can occur, please order early.

DTIC authorization to provide this service expires January 5, 1996, the DoD SBIR Program Solicitation No. 96.1 closing date.

REQUESTER____
Name

ORGANIZATIONNAME____________________________________

ADDRESS____
Street

__________________________________ PHONE__________________
City State Zip Code Area Code/Number

Send technical reports bibliographies on the following SBIR topics:

TOPIC NUMBER	TOPIC NUMBER		TOPIC NUMBER	TOPIC NUMBER
1________	6________		11________	16________
2________	7________	*PLEASE TYPE OR PRINT IN THE*	12________	17________
3________	8________	*ORDER TOPICS APPEAR IN THE*	13________	18________
4________	9________	*SOLICITATION*	14________	19________
5________	10________		15________	20________

Company Status: I confirm that the business identified above meets the SBIR qualification criteria presented in Section 2.2 of the DoD Program Solicitation.

This is our first request during the current solicitation: yes____no____.

____
Signature of Requester

========================FOLD HERE========================

STAMP

Return Address

Defense Technical Information Center
ATTN: SBIR
8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218

========================FOLD HERE========================

Associate Directors of Small Business assigned at Defense Contract Management Districts (DCMD) and Defense Contract Management Area Operations (DCMAO):

DCMD WEST
ATTN: Renee Deavens
222 N. Sepulveda Blvd., Suite 1107
El Segundo, CA 90245-4394
(800) 233-6521 (Toll Free CA Only)
(800) 624-7372 (Toll Free-AK,HI,ID,MT,NV,OR,WA)
(310) 335-3260
(310) 335-4443 (FAX)

DCMAO San Francisco
ATTN: Joan Fosbery
1265 Borregas Ave.
Sunnyvale, CA 94089
(408) 541-7042

DCMAO San Diego
ATTN: Marvie Bowlin
7675 Dagget Street, Suite 100
San Diego, CA 92111-2241
(619) 637-4922

DCMAO Seattle
ATTN: Alice Toms
3009 112th Ave., NE, Suite 200
Bellvue, WA 98004-8019
(206) 889-7317/7318

DCMAO Santa Ana
ATTN: Laura Robello
34 Civic Center Plaza, PO Box C-12700
Santa Ana, CA 92172-2700
(714) 836-2913 (ext. 659 or 661)

DCMAO Van Nuys
ATTN: Dianne Thompson
6230 Van Nuys Boulevard
Van Nuys, CA 91401-2713
(818) 904-6158 (ext. 201)

DCMAO St. Louis
ATTN: William Wilkins
1222 Spruce Street
St. Louis, MO 63103-2811
(314) 331-5392
(800) 325-3419

DCMAO Phoenix
ATTN: Clarence Fouse
The Monroe School Building
215 N. 7th Street
Phoenix, AZ 85034-1012
(602) 379-6170 (ext 231 or 229)

DCMAO Chicago
ATTN: Norma Thorpe
O'Hare International Airport
10601 W. Higgins Road, PO Box 66911
Chicago, IL 60666-0911
(312) 825-6021

DCMAO Denver
ATTN: Robert Sever
Orchard Place 2, Suite 200
5975 Greenwood Plaza Blvd.
Englewood, CO 80110-4715
(303) 843-4381
(800) 722-8975

DCMAO Twin Cities
ATTN: Otto Murry
3001 Metro Drive, Suite 200
Bloominton, MN 55425-1573
(612) 335-2003

DCMAO Wichita
ATTN: George Luckman
U.S. Courthouse Suite D-34
401 N. Market Street
Wichita, KS 67202-2095
(316) 269-7137

DCMD NORTHEAST
ATTN: John McDonough
495 Summer Street, 8th Floor
Boston, MA 02210-2184
(800) 321-1861
(617) 753-4317/4318
(617) 753-3174 (FAX)

DCMAO Boston
ATTN: Philip Varney
495 Summer Street
Boston, MA 02210-2184
(617) 451-4108/4109/4110

DCMAO Cleveland
ATTN: Herman Peaks
1240 East 9th Street
Cleveland, OH 44199-2064
(216) 522-5446

DCMAO Dayton
ATTN: Betty Adams
Gentile Station
1001 Hamilton Street
Dayton, OH 45444-5300
(513) 296-5150

DCMAO Detroit
ATTN: David Boyd
905 McNamara Federal Bldg, 477 Michigan Ave.
Detroit, MI 48226-2506
(313) 226-5180

DCMAO Garden City
ATTN: Eileen Kelly
605 Stewart Avenue
Garden City, NY. 11530-4761
(516) 228-5722

DCMAO Grand Rapids
ATTN: Kay Hamilton
678 Front Street, NW
Grand Rapids, MI 49504-5352
(616) 456-2620

DCMAO Hartford
ATTN: Frank Prater
130 Darlin Street
E. Hartford, CT 06108-3234
(203) 291-7705/7715

DCMAO Indianapolis
ATTN: Robert Staton
Building 1
Fort Benjamin Harrison, IN 46249-5701
(317) 542-2015

DCMAO New York
ATTN: John Castellane
207 New York Avenue
Staten Island, NY 10305-5013
(718) 390-1016

DCMAO Philadelphia
ATTN: Julia Graciano
2800 S. 20th Street, PO Box 7699
Philadelphia, PA 19101-7478
(215) 737-5818

DCMAO Pittsburgh
ATTN: Rich Spanard
1000 Liberty Avenue
Pittsburgh, PA 15222-4190
(412) 644-5926

DCMAO Reading
ATTN: Thomas Knudsen
1125 Berkshire Blvd., Suite 160
Reading, PA 19610-1249
(215) 320-5012

DCMAO Springfield
ATTN: Sylvia Liggins
955 South Springfield Ave.
Springfield, NJ 07081-3170
(201) 564-8343

DCMAO Stratford
ATTN: Otis Wade
550 Main Street
Stratford, CT 06497-7574
(203) 385-4416

DCMAO Syracuse
ATTN: Ralph Vinciguerra
615 Erie Boulevard, West
Syracuse, NY 13204-2408
(315) 448-7897

DCMD SOUTH
ATTN: Howard Head, Jr.
805 Walker Street
Marietta, GA 30060-2789
(800) 551-7801 (Toll Free-GA)
(800) 331-6415 (Nationwide)
(404) 590-6196
(404) 590-2612 (FAX)

DCMAO Atlanta
ATTN: Sandra Scanlon
805 Walker Street
Marietta, GA 30060-2789
(404) 590-6197
(404) 590-2110 (FAX)

DCMAO Baltimore
ATTN: Gregory W. Prouty
200 Towsontown Blvd.
Towson, MD 21204-5299
(410) 339-4809
(410) 339-4990 (FAX)

DCMAO Birmingham
ATTN: Lola Alexander
2121 Eight Avenue, N., Suite 104
Birmingham, AL 35203-2376
(205) 226-4304
(205) 251-5325 (FAX)

DCMAO Dallas
ATTN: Jerome Anderson
1200 Main Street, Room 640
PO Box 50500
Dallas, TX 75202-4399
(214) 670-9205
(214) 573-2182 (FAX)

DCMAO Orlando
ATTN: Victor Irizarry
3555 Maguire Boulevard
Orlando, FL 32803-3726
(407) 228-5113/5260
(407) 228-5312 (FAX)

DCMAO San Antonio
ATTN: Thomas Bauml
615 E. Houston Street, PO Box 1040
San Antonio, TX 78294-1040
(210) 229-4650
(210) 229-6092 (FAX)

DCDM INTERNATIONAL
DCMAO Puerto Rico
ATTN: Orlando Coriano
209 Chapel Drive
Navy Security Group Activity
Sabana Seca, PR 00952
(809) 795-3202
(809) 784-2011 (FAX)

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (*Leave Blank*)

2. REPORT DATE

3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE

5. FUNDING NUMBERS

6. AUTHOR(S)

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

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12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 words*)

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16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT

18. SECURITY CLASSIFICATION OF THIS PAGE

19. SECURITY CLASSIFICATION OF ABSTRACT

20. LIMITATION OF ABSTRACT

GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to stay within the lines to meet optical scanning requirements.

Block 1. Agency Use Only *(Leave blank).*

Block 2. Report Date. Full publication date including day, month, and year, if available (e.g. 1Jan88). Must cite at least the year.

Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10Jan87 - 30Jun88).

Block 4. Title and Subtitle. A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.

Block 5. Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C	- Contract	**PR**	- Project
G	- Grant	**TA**	- Task
PE	- Program Element	**WU**	- Work Unit Accession No.

Block 6. Author(s). Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

Block 7. Performing Organization Name(s) and Address(es). Self-explanatory.

Block 8. Performing Organization Report Number. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

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DOD - See DoDD5230.24, "Distribution Statements on Technical Documents."
DOE - See authorities.
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Block 20. Limitation of Abstract. This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.

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The DoD SBIR Program Office maintains a computerized listing of firms that have requested to be sent copies of the DoD SBIR Solicitations on a regular basis. If you would like to be remain or be added to this listing, please mail in this form.

☐ **YES**, Include my name and address on the DoD SBIR Mailing List

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COMPANY: ____

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CITY: ____________________ STATE: __________ ZIP: ________

PHONE: (_____)_________________________

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Defense Technical Information Center
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8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218

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